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Operation REDWING Interim Test Report Program 2 110837

FALLOUT STUDIES IN OPERATION REDWING

DRAFT

Victor A. J. Van Lint
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August 1956

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Field Command
Armed Forces Special Weapons Project
Albuquerque, N.M.

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ABSTRACT

Program 2 had the Department of Defense responsibility for the proper prosecution of the Nuclear Radiation and Effects Program in Operation REDWING. This report covers the portion of the program concerned with with the distribution of radioactivity in the cloud resulting from nuclear explosions and the subsequent fallout of material from the cloud.

Participation involved the following agencies: Evans Signal Laboratory; Naval Radiological Defense Laboratory; Scripps Institution of Oceanography; New York Operations Office, AEC; Chemical and Radiological Laboratories, ACC; and Air Force Special Weapons Center. REDWING large yield events ~~having~~ in which there was primary participation were Cherokee, Zuni, Flathead, Navajo, and Tewa with secondary measurements made on events LaCrosse and Mohawk.

A wide variety of instrumentation was employed by the various laboratory groups. Rockets and manned aircraft made penetrations into the cloud and stem. Instruments recorded the time of arrival of fallout, collected incremental and gross samples of fallout, and measured the radioactivity in the air, on land surfaces, and in the lagoon and ocean waters. Samples were collected by a number of different means, including manned ships in the downwind fallout area; skiffs deep moored in the open ocean; barge, raft, and land stations in the Bikini Lagoon. Aircraft and ships were used to survey the open ocean areas, helicopters with detectors suspended below and monitor teams surveyed the land areas. The water in the lagoon was examined.

Data consisted of time and rate of arrival of radioactivity; character of fallout material including particle size, composition, and activity, total exposure on land; and exposure rates on land, in the air, and in the lagoon and ocean water. Wind data and the size and shape of the visible cloud and stem were recorded to assist with the analysis of the fallout pattern.

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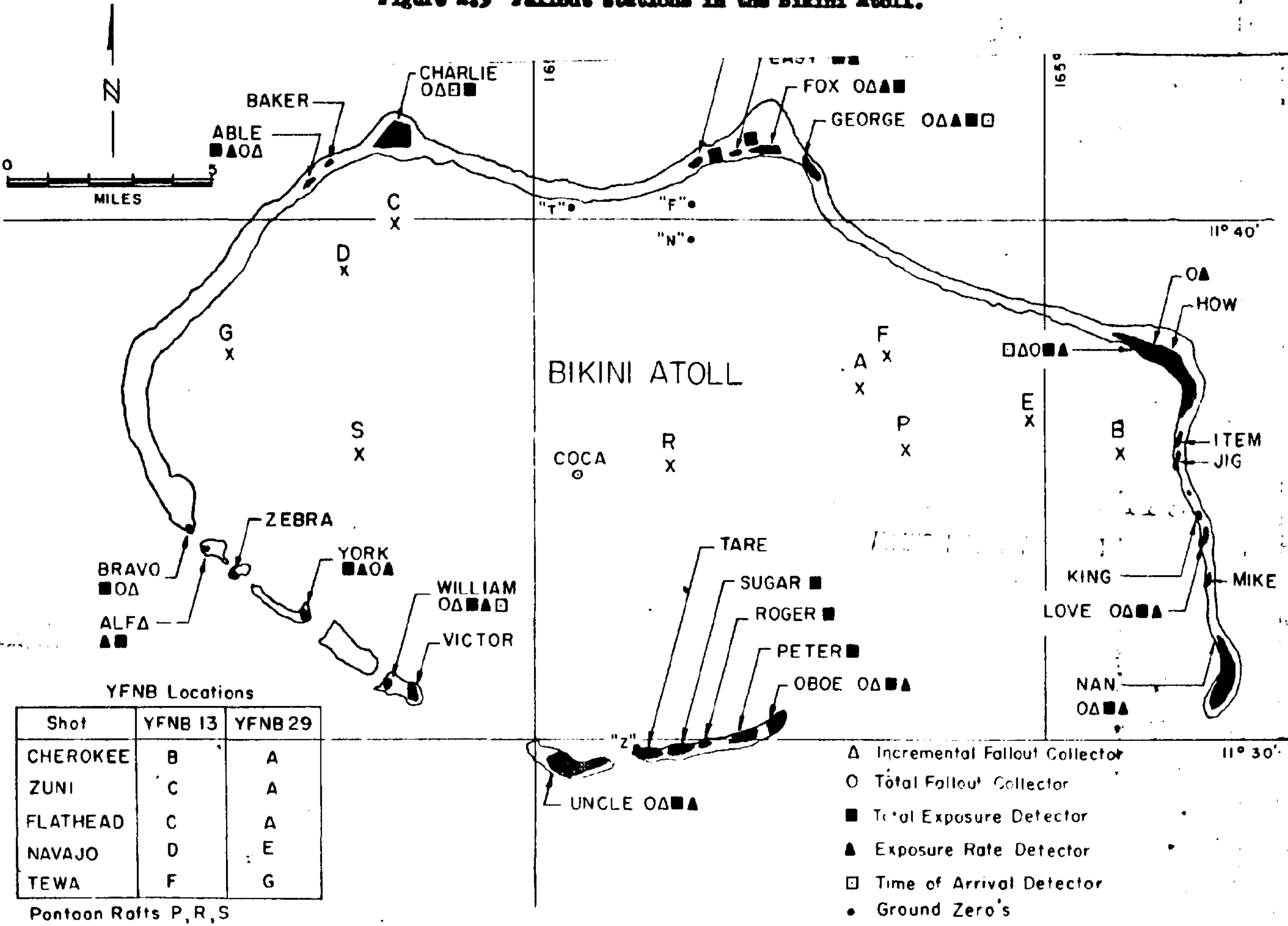
Figure 2.3 Fallout stations in the Bikini Atoll.



YFNB Locations

Shot	YFNB 13	YFNB 29
CHEROKEE	B	A
ZUNI	C	A
FLATHEAD	C	A
NAVAJO	D	E
TEWA	F	G

Pontoon Rafts P, R, S

Figure 3.2 Zuni Cloud at H+7 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.

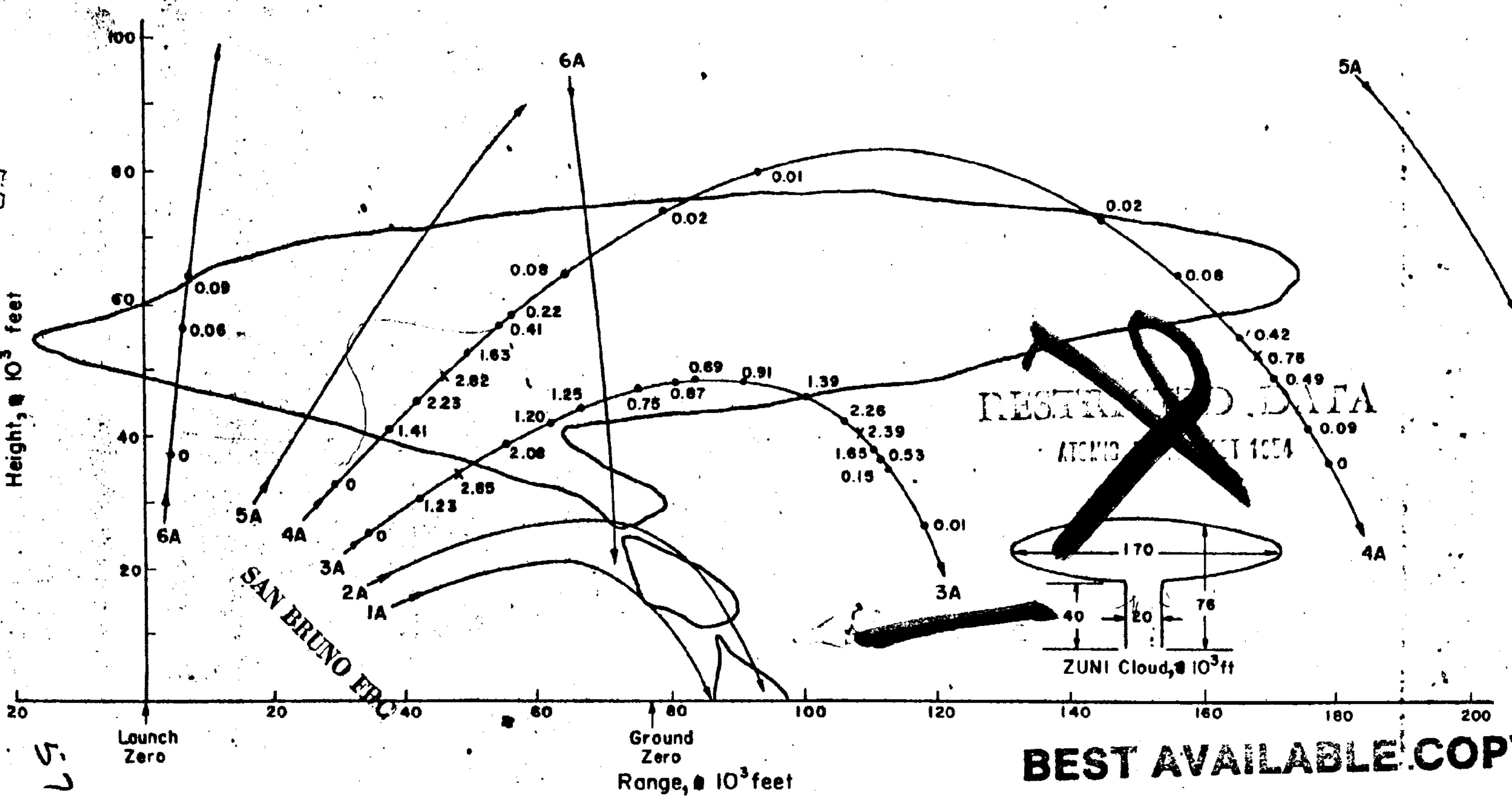
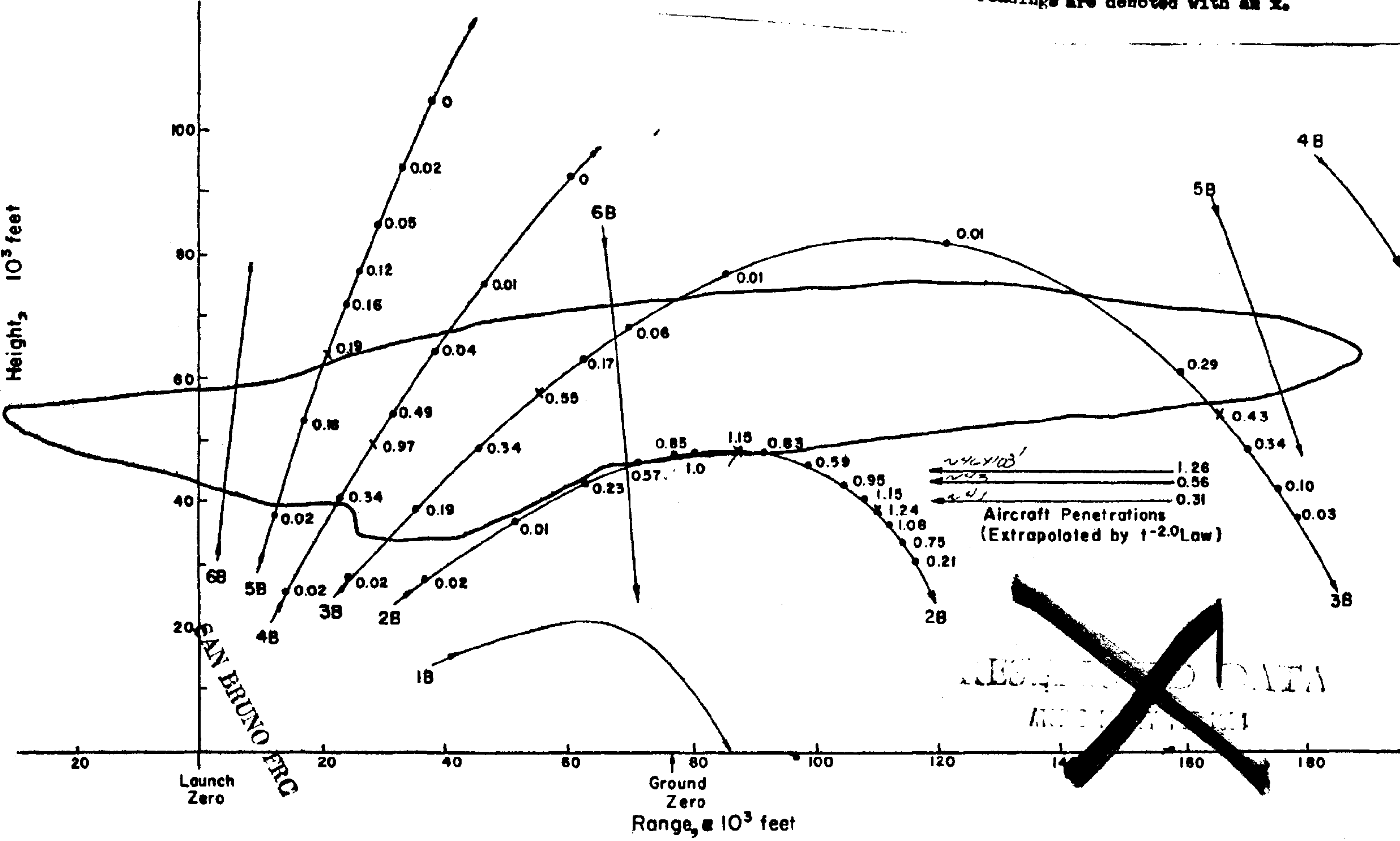


Figure 3.4 Zuni Cloud at H+15 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.



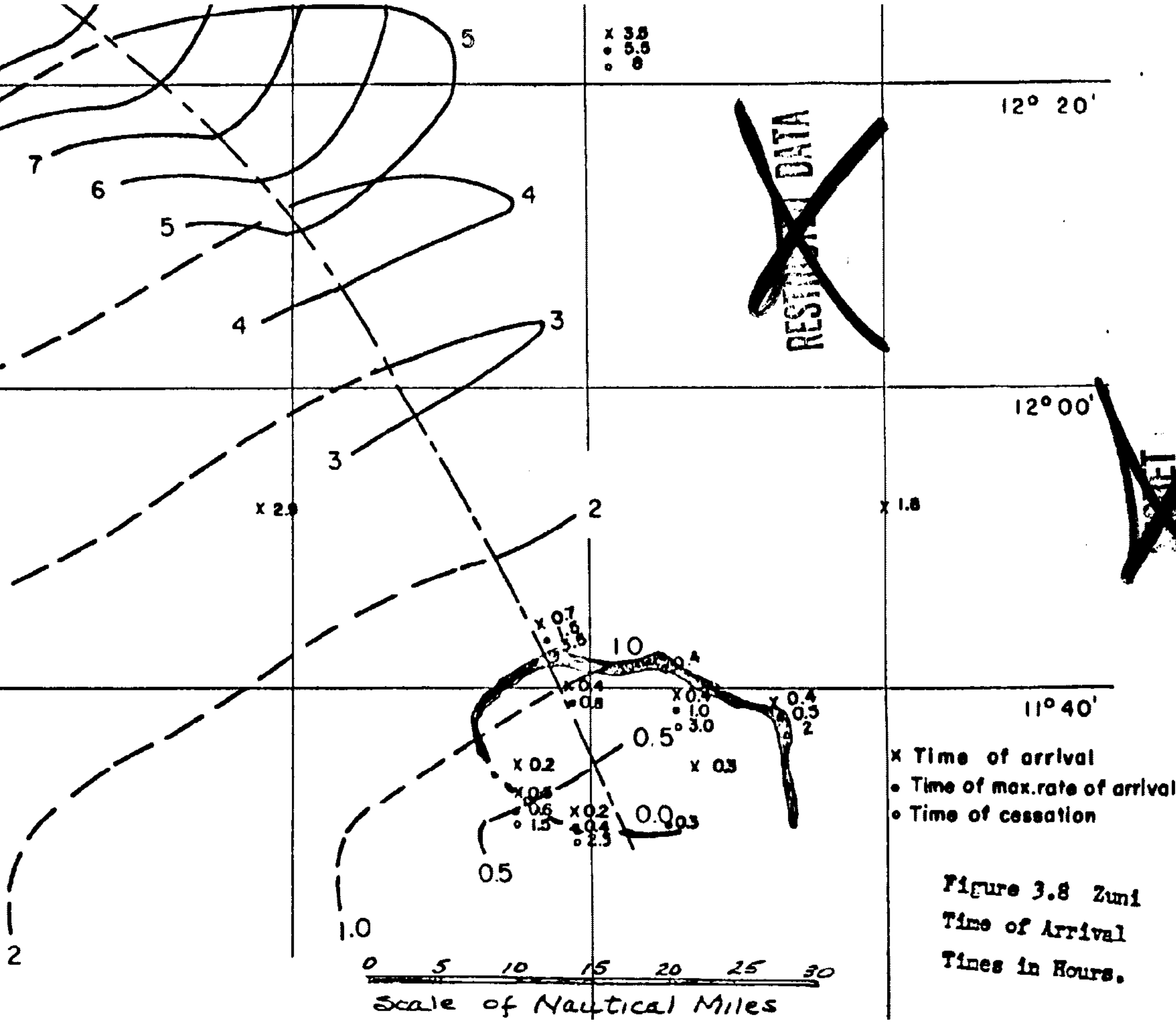


Figure 3.8 Zuni Time of Arrival Times in Hours.

— — Stem Region (< 45,000 ft)

——— Cloud Region (> 45,000 ft)

- —— - 45,000 ft Line

(a) Time of arrival detectors on the skiffs and pontoon rafts.

(b) Gamma "time-intensity recorders" aboard YAG 39, YAG 40, LST 611, YFNB 13, YFNB 29, and the Site How station of Project 2.63.

(c) Monitor of trays of incremental samplers located aboard ships by Project 2.63 and on islands by Project 2.65.

~~(d) The gamma exposure rate recorders installed at some land stations~~

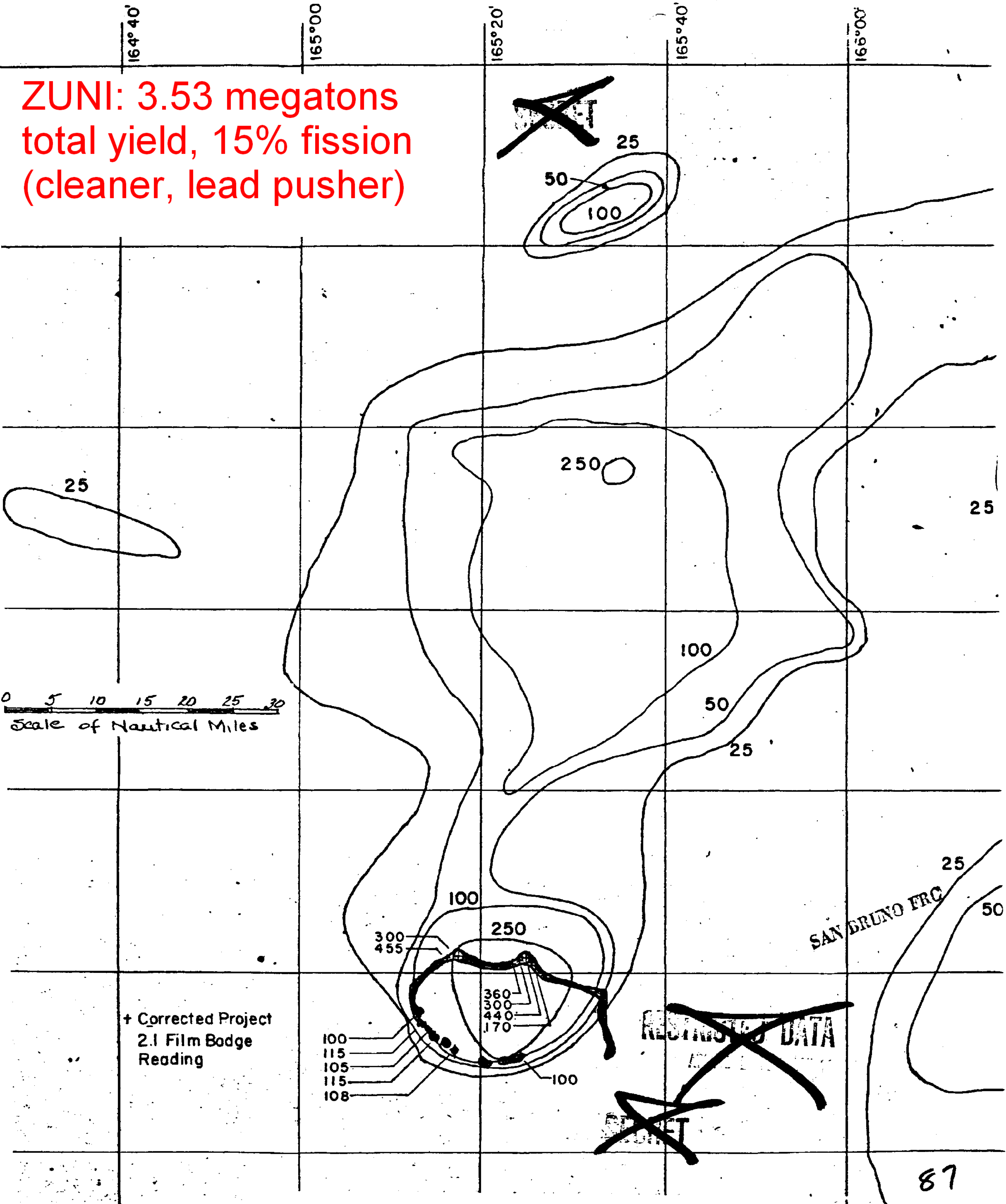


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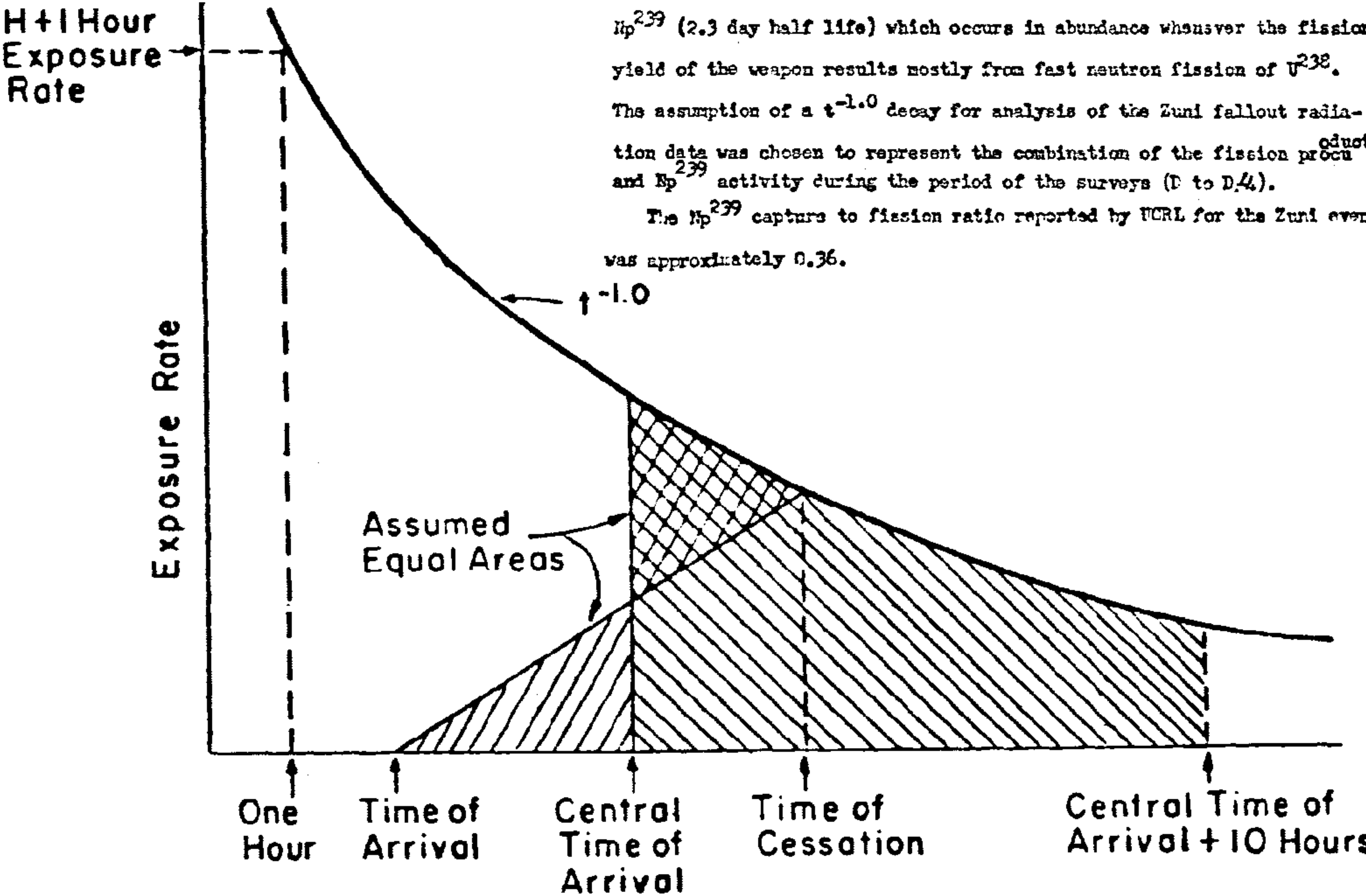
Figure 3.9 Zuni Ten Hour Exposure Contours. Exposure in r.

EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION

Np^{239} (2.3 day half life) which occurs in abundance whenever the fission yield of the weapon results mostly from fast neutron fission of U^{238}. The assumption of a $t^{-1.0}$ decay for analysis of the Zuni fallout radiation data was chosen to represent the combination of the fission product and Np^{239} activity during the period of the surveys (D to D+4).

The Np^{239} capture to fission ratio reported by UCRL for the Zuni event was approximately 0.36.



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A wide variety of instrumentation was employed by the various laboratory groups. Rockets and manned aircraft made penetrations into the cloud and stem. Instruments recorded the time of arrival of fallout, collected incremental and gross samples of fallout, and measured the radioactivity in the air, on land surfaces, and in the lagoon and ocean waters. Samples were collected by a number of different means, including manned ships in the downwind fallout area; skiffs deep moored in the open ocean; barge, raft, and land stations in the Bikini Lagoon. Aircraft and ships were used to survey the open ocean areas, helicopters with detectors suspended below and monitor teams surveyed the land areas. The water in the lagoon was examined.

Data consisted of time and rate of arrival of radioactivity; character of fallout material including particle size, composition, and activity, total exposure on land; and exposure rates on land, in the air, and in the lagoon and ocean water. Wind data and the size and shape of the visible cloud and stem were recorded to assist with the analysis of the fallout pattern.

No fallout was measured from the Cherokee air burst. Preliminary results show a difference in the nature of fallout material between water surface (Flathead and Navajo) and land surface (Zuni and Tewa) bursts. The former consisted of an aerosol, mud, and a salty slurry and the latter of a fine dry solid material resembling modified coral. High exposure rates were measured in the lower layer of the cloud and little activity was detected in the stem although large active particles were collected which apparently came from lower stem altitudes. Particle fall, time of arrival, and exposure plots have been developed from the data. EXPOSURE AND RATE CONTOURS ARE FROM PRELIMINARY DATA AND MUST BE USED WITH CAUTION. Some in-close readings are given and those near the Mohawk crater extrapolated to H/1 hour in many cases exceeded 10,000 r/hr. These values are higher than any previous extrapolated data based on D-day measurements.

It is tentatively concluded for the size of shots involved that radioactive fallout material originates in the lower layer of the nuclear cloud and that there is relatively little activity in the stem.

A minimal light air burst (fireball just above surface) over water does not produce fallout of military significance.

For weapons of equal total yield with conditions of corresponding [illegible] the exposure rate from surface burst fallout is probably proportional to the radiological yield.

Tentatively and within the definitions of this report a [redacted] yield) surface burst will ~~produce~~ contaminate an area of over 1,500 square miles ~~contaminated~~ to a level which will be lethal to externally exposed personnel. The sickness area will comprise more than 3,500 square miles.

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FOREWORD

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PREFACE

This report is a summary and consolidation of the preliminary information available on the fallout studies at Operation REDWING. Data is presented from many of the projects in Program 2 which worked individually and in close cooperation to document the fallout. Appendix A gives some information on the individual projects and the type of data each obtained. A number of projects also gathered data on other problems such as initial radiation and contamination and decontamination. The preliminary results of these efforts are not included in this report since they will be presented in detail in the individual project reports and are also covered in the Task Unit 3 Summary Report.

Since this report was written within a few weeks after the conclusion of Operation REDWING, the data is necessarily preliminary and subject to possible major changes. Much of the data from detailed laboratory analysis of the fallout samples and from careful interpretation of the records was not available. However, it was felt that the general fallout picture, including the estimated radiation contours for the individual events, was of sufficient immediate interest to warrant presentation of the results although they were subject to change.

This consolidation would not have been possible without the cooperation and assistance of the following Project Officers and their projects:

Mr. Peter Brown, Projects 2.1 - 2.2, Evans Signal Laboratory;

Mr. Richard R. Soule, Project 2.61, Naval Radiological Defense Laboratory;

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Mr. Feenan D. Jennings, Project 2.62, Scripps Institution of Oceanography;

Dr. Terry Triffet, Project 2.63, Naval Radiological Defense Laboratory;

Mr. Robert T. Graveson, Project 2.64, New York Operations Office, AEC;

Mr. Manfred Morgenthau, Project 2.65, Army Chemical Center;

Colonel Ernest A. Pinson, USAF, Project 2.66, Air Force Special Weapons Center;

Mr. Heinz Rinnert, Project 2.71, Naval Radiological Defense Laboratory; and

Mr. Michael M. Bigger, Project 2.10, Naval Radiological Defense Laboratory.

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FIGURES

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CHAPTER 1

INTRODUCTION

The material in this report is organized around the three basic types of shots in Operation REDWING in which fallout was documented: land surface, air, and water surface bursts. The land surface bursts will be discussed in detail, and where possible, the other types of shots will be discussed by comparison with the land surface burst phenomena.

1.1 LAND SURFACE BURSTS

1.1.1 Definition. A land surface burst is defined as the explosion of an atomic weapon at the surface of land or at a height above the surface less than the fireball radius at the time of break-away of the shock front. Based on the test results from atomic weapons to date, the fallout contamination can be of primary importance for such a burst, extending the area in which personnel casualties are inflicted far beyond the regions of blast and thermal effects, and denying access to some areas for a long post-shot period. BEST AVAILABLE COPY

1.1.2 Previous Test Results. Only four land surface shots, as shown in Table 1.1, have been documented for fallout to any appreciable extent. These were the surface ("S") shot in Operation JANGLE, the MIKE shot in Operation IVY, and the BRAVO and KOON shots in Operation CASTLE.

1.1.2.1 JANGLE Surface Shot. On the JANGLE surface shot the distribution of bomb debris was documented in detail, particularly close in. The low yield of [redacted] made it possible to survey the radiation pattern directly with hand and vehicle carried survey instruments.

TABLE 1.1 Summary of Data on Previous Land Surface Shots

Shot	Yield	Date and Location	Remarks	References
JANGLE Surface	DELETED	19 Nov 51. Yucca Flat, Nevada Test Site.	Fallout was well documented, particularly close in.	1 thru 16
IVY MIKE (Shot 1)		1 Nov 52. FLORA, Eniwetok Atoll.	Fallout was documented in the upwind and crosswind directions.	10, 11, 17, 18, 19
CASTLE BRAVO (Shot 1)		1 Mar 54. West of CHARLIE on reef, Bikini Atoll.	Close in fallout was well documented considering damage to instrumentation. Some late survey data was obtained about 150 miles downwind.	10, 11, 20 thru 27
CASTLE KOON (Shot 3)		27 Mar 54. West end of TARE, Bikini Atoll.	Fallout instrumentation limited. Documented about 15 miles downwind.	10, 11, 20 thru 27

Measurements of the quantity of fallout material, time of arrival, and rate of arrival were obtained. Fairly complete radiochemical and radiophysical analyses of the fallout particulate were made. The 100 r/hr contour at 1 hour after detonation extended more than 4,000 yards downwind and had a crosswind extent of 500 yards. The downwind distance extended well beyond the region of blast and thermal damage and therefore the JANGLE results showed appreciable areas with fallout of military significance. Considerable fractionation was observed in the fallout from the JANGLE shot and a dependence of the radiochemical composition upon particle size was indicated. The distribution of activity with particle size and the distribution of activity on and within particles was studied in detail. It was found that almost all the activity was associated with particles larger then 100 microns in diameter. Results also showed that activity was distributed uniformly in some particles while in other particles this was not true. The activity was almost never found to be concentrated near the outside of the particle. Active particles ranged from being colorless to jet black, but the activity was usually associated with the darker colors.

1.1.2.2 The IVY MIKE Shot. The IVY MIKE shot of about [redacted] was documented only in the upwind and crosswind directions. Measurements of the crosswind fallout arrival times were independent of distance from ground zero and the duration of the observed fallout was approximately 1 to 2 hours. No evidence of any particle size fractionation with crosswind distance was found and there were only meager indications of particle size fractionation with time.

1.1.2.3 CASTLE BRAVO Shot. Shot 1 in Operation CASTLE was a land surface burst with a yield of [redacted]. This shot produced fallout at levels of military significance over a tremendous area. Results of this shot showed that weapons of this type and yield can be expected to produce levels of residual radiation hazardous to human life over several thousand square miles. The threshold value for radiation levels of military significance is indeed difficult to specify quantitatively since it varies widely, depending upon the particular effect under consideration. However, in this report, radiation levels above 5 r/hr at 1 hour after detonation are arbitrarily considered to have military significance. (Reference 28.) Gamma levels of military significance were found to exist at a downwind distance of at least 280 nautical miles. It was concluded that an area upwards of 20 miles in width and 120 miles in length downwind would produce casualty effects in the case of this type of surface land detonation with a yield in the [redacted] range. The data showed a substantial contribution to the residual activity from neutron capture products of U^{238} including U^{237}, U^{239} and its daughter Np^{239}, and Np^{240}. This contribution influenced markedly the gamma energy distribution and decay rate. Theoretical considerations indicate that the relative contribution from the Np^{239} builds up to a maximum four days after the shot and its effect is to reduce the gross decay rate below that of the fission products alone.

1.1.2.4 CASTLE KOON Shot. The KOON shot at CASTLE had a yield considerably less than the BRAVO shot. Because of previous damage to the instrumentation and operational difficulties, fallout documentation for for this shot was limited to total collection type instrumentation.

1.1.3 Mechanism of Fallout. When a nuclear detonation occurs, the long lived radioactive products formed are of three types:

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a. Fission products.

b. Neutron capture products formed in the reacting bomb materials.

c. Neutron capture products formed in the neighborhood, such as the inert bomb materials, enclosing building, and the nearby land or water.

In pure fission weapons the first of these types predominates over the others. When an appreciable part of the fission yield results from secondary fission of U^{238}, the neutron capture products, particularly Np^{239}, contribute significantly to the activity during the subsequent days. In any case, the activity induced in the local soil and other neighboring materials is completely masked whenever it is in the presence of fission products and activity from neutron capture products. When a weapon is detonated so that a portion of the fireball intersects the ground, an appreciable amount of ground material becomes incorporated in the fireball in the gaseous, liquid, and even solid state. This material becomes intimately mixed with the fission and activation products. As the fireball cools, this material condenses and a considerable fraction of the activity becomes associated with the material particles. The rapid upward movement of the fireball and ensuing cloud[1] probably carries this material upward and subsequently outward with the radial expansion of the cloud.

Once the turbulent motion in the cloud has abated, the particles commence to fall at a rate determined by their size and to move horizontally with the local air motion. Those particles with a diameter greater than 75 microns will fall to the surface within a day and

[1] For the purpose of this report the cloud is defined as the upper part of the nuclear mushroom. The mushroom therefore consists of the cloud and stem.

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contribute to the local fallout contours. Smaller particles take longer times to settle and are also influenced appreciably by vertical air motions. Air turbulence and various weather disturbances result in a pertubation of the fallout pattern.

The problem of detailed fallout prediction then naturally separates itself into two parts. The first is the establishment of an appropriate model for the initial mushroom ~~cloud~~, including the distribution of activity as a function of particle size and position at a time when the turbulent motions no longer affect the particles, that is, when they are moved only by gravity and the prevailing wind. This initial distribution is expected to be a function of the total yield and fission yield of the weapon and its environment, and also to be affected somewhat by the meteorological conditions, particularly the location of the tropopause. In addition, there are a number of other considerations such as peculiar condensation and falling effects, i.e., change in particle size with time, which play a role in any detailed model.

The second part of the analysis involves the prediction of the time of arrival and location on the surface associated with each position and particle size in the mushroom ~~cloud~~ and hence the construction of intensity contours. This procedure involves the complete wind structure in the area of fallout from shot time until the time all the fallout of interest has reached the surface. Such a complete analysis as is outlined above involves the use of detailed weather data and would, in general, be very time consuming. For tactical military situations and civil defense applications, the accuracy desired does not demand such a

complete analysis but the answers are desired in a short time. Therefore, it is convenient to describe the fallout pattern in terms of a few parameters such as area, downwind distance, crosswind distance, size of circle around ground zero, etc.

The scaling relations for these parameters can then be established in terms of weapon and environmental characteristics and a gross estimate of the meteorological conditions.

Experiments on fallout scaling models have been conducted with high explosive charges ranging from 150 pounds to 50 tons exploded on a land surface. The JANGLE surface shot yielded data at 1.2 KT and the IVY MIKE and CASTLE BRAVO data represent points at 10-15 MT, a yield factor of 10^4 higher than JANGLE. The large yield data that was obtained was particularly sparse in both the downwind and crosswind directions.

The simplest scaling law that has been proposed involves scaling all contour dimensions, as well as the contour values, by the cube root of the yield. This procedure conserves the total material in the weapon and implies the same fraction of all size weapons to be locally deposited. The limited measurements performed for CASTLE BRAVO, however, indicate contour dimensions appreciably larger than the values scaled from the JANGLE surface shot and therefore a procedure of scaling by interpolation between measured values is probably much more reliable. Curves have been developed which are based on all the available data and are most practical for rapid rough estimates (Reference 29).

Obviously, insufficient fallout test data has existed to perform reliable scaling. The most profitable plan of attack on this problem

is probably to first develop a detailed model and then infer the scaling laws from it. In this way the effect of other parameters such as wind speed and shear can be better evaluated. Therefore, the primary goal of the fallout documentation at Operation REDWING was to analyze the fallout in every detail as completely as possible and thereby to contribute to the development of a detailed model.

1.1.4 Objectives. The general objective of the Fallout Program in Operation REDWING was the complete fallout documentation of shots CHEROKEE, ZUNI, FLATHEAD, NAVAJO, and TEWA with some incidental participation on other shots of generally smaller yield. The following were the specific objectives in documenting the fallout:

1.1.4.1 Collection of the Fallout Material. This objective includes the collection of the fallout material at the following stations:

1. Islands of Bikini Atoll.
2. Floating collection platforms located in the Bikini Lagoon and ocean fallout area.
3. In the ocean water.
4. At a remote atoll location (Rongerik).

1.1.4.2 Radiation Readings Over Land Type Surfaces. One objective was to gather radiation readings at the above mentioned locations which could be reduced to yield the contours that would have existed if the fallout had occured over an equivalent land area.

1.1.4.3 Distribution of Activity in the Ocean Areas. This objective was to make use of the ocean as a collector of activity and to evaluate a method of inferring land surface radiation contours from radiation measurements in and above the ocean.

Mushroom

1.1.4.4 Distribution of Activity in the Nuclear Cloud. This objective was to obtain data on the initial distribution of activity in the stabilized ~~cloud~~ mushroom and to test a method of obtaining such data with rocket borne detector-telemeter units. The intent was to obtain data to compare the relative activity of the cloud and stem and the distribution of activity within each of these regions. In addition, it was expected that some additional data on the distribution of activity in the ~~cloud~~ mushroom and the exposure rates to personnel would be obtained from manned aircraft flights into the cloud and stem at times of 1/2 to 1 hour after detonation.

1.1.4.5 Analyses of the Collected Fallout Material. Various physical and chemical analyses on the fallout material were planned to give the following information:

1. Particle size distribution as a function of time of collection and location.
2. Gross decay of the fallout activity (starting at very early times).
3. Distribution of activity on and within particles and as a function of particle size.
4. Quantity of certain individual nuclides and fractionation.

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1.2 AIR BURSTS

1.2.1 Definition. The air burst of an atomic weapon is defined as one in the air above land or water at a height greater than the radius of the fireball.

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1.2.2 Previous Test Results. A number of tests of weapons of relatively small yields in Nevada have given results which show that the

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fallout of radioactive material from an air burst is essentially negligible from a military standpoint. These tests were performed with air drops and bombs detonated on towers at such heights that the fireball did not reach the surface of the earth. The largest yield air burst prior to Operation REDWING was the IVY KING shot which was detonated at an altitude of 1,500 feet on 16 November 1952, over the ocean north of YVONNE at Eniwetok Atoll. The yield was approximately [redacted] Some very rough measurements on islands in Eniwetok Atoll indicated that the fallout activities were so small that at times as early as 6 hours after KING shot, the observed ~~intensities~~ exposure rates at all islands except YVONNE ~~were~~ could be ~~consistent with~~ attributed to the 15 day old fallout from MIKE shot. On YVONNE, within 4,000 feet of the ~~birst~~ burst point, the ~~intensity~~ exposure rate (of the order of 25 R/hr at H+1 hr.) was only about 2 per cent of the activity produced by the fallout from the ivy mike shot at 18,000 feet from ground zero at comparable times after each shot. It was therefore concluded that there is little external radiation hazard from fallout due to an air burst at a scaled height as high as that of KING shot. BEST AVAILABLE COPY

1.2.3 Mechanism of Contamination. Previous weapons tests have consistently shown that air bursts, whether air drop or tower shots, produce little fallout contamination as compared to the same yield land surface burst. The conclusion from such data is that the hot fission products do not have an opportunity to condense onto the ground particulate matter picked up by the cloud. However, observations of air bursts of kiloton weapons have shown that a thin stem consisting of ground material is sucked up into the center of the rising fireball. There are two possible explanations as to why the radioactive material

does not deposit on this material: (1) by the time the ground material arrives, the fireball may have cooled sufficiently so that the fission products have solidified and are no longer available for deposition on other matter. (2) The internal motion of the fireball may be such that the ground material and the fission products do not come in contact. For example, the observed toroidal motion might consist of the bomb products in a narrow internal ring with the ground material flowing over the surface.

If either of these reasons explains the lack of contamination for previously observed air bursts, there is no guarantee that they will also hold for multimegaton bursts. The fireball remains hot for a longer period of time and the internal motion could differ in character between widely different yields. Therefore, in view of the great tactical importance of a low air burst in offensive military operations, the documentation of fallout from a weapon in the megaton range detonated at a height slightly greater than the fireball radius was essential.

1.2.4 Objectives. The broad objective was simply to establish whether or not there was radioactive fallout of military significance from a megaton weapon detonated at minimal air burst conditions over a land surface. This objective could be accomplished by simply documenting the fallout completely in accordance with the detailed objectives for the surface land shot.

1.3 WATER SURFACE BURSTS

1.3.1 Definition. A water surface burst is defined as one exploded at the surface of water or at a height above the surface less than the fireball radius.

[redacted]

1.3.2 The Role and Military Significance of Barge Shots. The firing of a nuclear weapon mounted on a barge is truly a water surface shot because it is detonated within a few feet from the surface. The use of barges in firing nuclear weapons was introduced at Operation CASTLE where four of the six shots were located on barges. Table 1.2 presents the summary data on these shots. The use of this technique has been adopted principally for operational reasons; namely, the shot site can be prepared easily for the next event and the device is very portable in case of a change in plans. As far as the fallout program ~~is~~ was concerned, the barge shot had a direct significance in terms of the effects of a deep harbor burst and may give information applicable to a burst on the surface of the open ocean. In addition, the basic dynamics of the cloud development should not be modified too much by the presence of water and it can be expected that a more complete understanding of the fallout from a barge shot, coupled with particle information from a few land surface bursts, can improve the state of knowledge of the fallout from land surface detonations.

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1.3.3 Barge Shots at Operation CASTLE. The first shot at CASTLE had a yield much greater than expected and this resulted in a serious curtailment of the fallout program on this operation. A large number of experimental failures and equipment losses resulted from blast and water wave action, delays in shot schedules, and operational difficulties associated with the sampling of fallout over extended ocean areas. Consequently, fallout documentation of the barge shots was quite limited. However, a considerable amount of data was obtained from analysis of the

TABLE 1.2 Summary of Data on Previous Water Surface Shots

Shot	Yield	Date and Location	Remarks	References
CASTLE ROMEO (Shot 2)	DELETED	27 Mar 54. Barge in CASTLE BRAVO crater on CHARLIE Reef, Bikini Atoll.	Good crosswind fallout data but limited in the downwind direction.	20 thru 27
CASTLE UNION (Shot 4)		26 Apr 54. Barge in Bikini Lagoon.	Fallout documentation fragmentary. Limited upwind and crosswind data.	20 thru 27
CASTLE YANKEE (Shot 5)		5 May 54. Barge in Bikini Lagoon.	Water survey and sampling techniques used. No Bikini Atoll fallout instrumentation due to loss and damage.	20 thru 27
CASTLE NECTAR (Shot 6)		14 May 54. Barge in IVY MIKE crater on FLORA, Eniwetok Atoll.	Extensive instrumentation in Lagoon and northern atoll islands. Limited fallout data. Generally low levels of activity except few samples near ground zero.	20 thru 27

water samples and fallout material. There were indications that much of the contamination was in the form of an aerosol and hence differed from the fallout from a land surface burst.

1.3.4 Objectives. Again, the objective of the Fallout Program was the complete documentation of fallout from the barge shots. This was done by implementing the same detailed objectives as those for the land surface burst. The intent was to learn just how the fallout varied with the different yield barge shots and specifically how it differed from the land surface burst and air burst fallout.

1.4 OTHER TYPES OF BURSTS

From the standpoint of weapons effects, and in accordance with definitions mentioned earlier, the explosion of an atomic weapon at the top of a tower may be either an air burst or a surface burst depending on whether or not the fireball comes in contact with the surface, although the air burst characteristics may be slightly modified by the presence of the tower. However, the Fallout Program did not document completely any tower shots in Operation REDWING. The only other types of shots that have not been considered thus far in this report are the underwater and underground bursts. Operation REDWING did not include any shots of these types and therefore no attempt has been made to discuss their fallout phenomenology.

1.5 EFFECT OF FRACTIONAL RADIOLOGICAL YIELD

Operation REDWING provided the first opportunity for testing weapons in which the [redacted] In this report the fractional radiological yield is defined as the ratio of

the fission yield to the total yield. It is to be expected that the effect of this extra parameter, the fractional radiological yield, on the fallout would be as follows: The location of the contours as well as the weight of non-radioactive material deposited should be a function of the total yield, but the gamma dose rate associated with each contour should be scaled proportionally to the fractional radiological yield. The amount of fission product material deposited is obviously scaled by the fractional radiological yield. In general, the definition of the fractional radiological yield can be extended to describe induced activity in bomb materials or "salting agents." In the case of "salted" weapons, this quantity could then be greater than unity since extra activity might be added without contributing to the total yield of the weapon.

1.6 SUMMARY OF PROGRAM OBJECTIVES

The overall objective of the Fallout Program was to document completely the fallout from the shots of interest. Complete collection of data on the numerous parameters was necessary to improve scaling laws, to better understand the mechanism of fallout, and hence improve present fallout models.

For the high yield minimal air burst, CHEROKEE, in particular, the objective was to determine if there was any fallout of military significance.

In the case of the ~~water~~ surface shots it was expected to establish in detail just how fallout from water surface bursts differs from that due to land surface bursts.

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CHAPTER 2

EXPERIMENTAL DESIGN

2.1 REQUIREMENTS FOR DATA

Based on the detailed objectives outlined in the previous chapter, the instrumentation for the fallout program was designed to ~~obtain~~ perform the following ~~data~~ functions:

a. Collection of Fallout Material

b. Obtain Radiation Readings Over Land Surfaces

c. Obtain Radiation Readings In and Above Ocean and Lagoon Water

d. Obtain Radiation Readings In the Nuclear ~~Cloud~~ Mushroom.

2.2 INSTRUMENTATION

In some instances, more than one agency had equipment that performed the same function, e.g. the time incremental collection of fallout material. In such cases the detailed features of the equipment were different since the equipment was designed and built by different agencies. No attempt has been made in this report to give a detailed description of the individual pieces of equipment. For further information the reader is referred to the individual project reports. Instead, instrumentation will be discussed as general types and according to its function.

2.2.1 Collection of Fallout Material.

2.2.1.1 Total Collectors. Total or gross collectors were used to collect the fallout material throughout the duration of fallout. One total collector used by Project 2.65 at its distant collector station was simply a wooden tray four feet by four feet by 18 inches deep. A

total collector used by Project 2.63 was a tray three feet square by two inches deep. A variation of this latter type utilized the same tray design but added a layer of fiber glass honeycomb and had a cover which was designed to open and close before and after fallout, respectively. This covering was provided to preserve the samples and prevent any modification by environmental conditions before and after collection. A third type of gross collector used by Project 2.65 was conical with an opening at the top two feet in diameter and narrowing to a circle about 5 inches in diameter at the bottom where there was a stainless steel filter. Below the filter there was a small hose leading to a polyethylene bottle. The cover of the collector was designed to open upon a timing signal and then close automatically eleven hours later. A similar type of total collector used by Project 2.63 consisted of a 7 inch diameter funnel with a one-half inch diameter tube and a two gallon bottle, all of polyethylene, with a fiber glass honeycomb layer in the mouth of the funnel. A final type of a total collector used by this project consisted of filter paper through which fallout air was sucked by a pump.

2.2.1.2 Incremental Collectors. The largest number of incremental type collectors used were located at the Project 2.65 land stations and consisted of a covered steel tub 40 inches in diameter and 24 inches high. Fitting into this tub was a circular disc with 22 triangular

sampling trays, each 3 3/8 inches by 10 inches by 3/4 inch deep. By means of a driving and timing mechanism, one tray at a time was exposed to the open air through a hole, the size of the sampling tray in the top cover. A door covered the sampling hole before the initial and after the final sampling. An external timing signal started the mechanism and succeeding trays moved into position at set time intervals. Exposure durations of 1 minute, 5 minutes, and 30 minutes were used for various collectors. The Project 2.63 type of incremental collector used was essentially a rainfall sampler in which the collecting trays had been modified. These trays exposed sensitive collecting surfaces about 3 inches in diameter successively for equal time increments. The trays were placed in the exposure position by means of a pair of interconnected vertical elevators. Each tray was exposed at the top of the ascending elevator and after exposure was pushed horizontally across to the descending one. For land surface shots, a grease coated cellulose acetate disc was used as a collection surface and for water shots, the same surface ~~were~~ was interspersed with discs of chloride sensitive films.

An experimental high volume filter unit was also used by Project 2.63. This device was, in effect, an incremental air sampler. It was designed to obtain gross aerosol samples in significant quantities under conditions of low concentration. It consisted of a single blower and 8 filter heads oriented upward enclosing 3 inch diameter filter packs that were changed at specified time intervals.

Project 2.65 used a tape fallout monitor which was an intermittent type of collector employing adhesive tape for the sampling surface which was exposed for periods of one minute for the first hour and periods of one hour for the next 47 hours. The instrument had a second reel of Saranwrap plastic tape which covered the exposed collecting tape at the end of its exposure period.

2.2.2 Radiation Readings Over Land Type Surfaces.

2.2.2.1 Total Exposure[1] Detectors. Film packs, chemical vials, and direct reading dosimeters were used as total exposure detectors. Some of these detectors were placed at all land as well as floating stations. Most of the processing and data reduction was performed by Project 2.1.

2.2.2.2 Gamma Exposure Rate Meters. A device know as "Conrad I" was used by Project 2.2 for the measurement of gamma exposure rates over a range of 1 r/hr to 10^4 r/hr with a time resolution of 5 minutes and 0.05 minutes respectively at these exposure rates. It consisted of an unsaturated ion chamber as the sensing device and an Esterline Angus pen recorder. A second instrument similar to the one above and designed to operate over a range from 0.2 mr/hr to 3600 r/hr, was used by Project 2.63. Project 2.65 used a probe lowered from a helicopter to measure gamma exposure rates at 3 feet above the ground. The probe contained a

1. In this report the word "exposure" will be used to describe the radiation as measured in roentgens.

detector element which was the ionization chamber from a Jordan model AGB-10K-SR survey meter. The output current from the chamber and associated curcuitry flows through the probe wire to the indicating meter mounted in the helicopter. The range of this instrument was from 0.01 mr/hr to 10^4 r/hr.

2.2.2.3 Time of Arrival Detectors. Project 2.63 used a time of arrival detector consisting of an ionization chamber which triggered an 8 day chronometric clock when an exposure rate of 20 mr/hr for a period of a half hour was reached. Subtracting the clock reading at recovery time from the known time since detonation yielded the time of arrival of the fallout.

2.2.3 Radiation Readings In and Above Ocean and Lagoon Water.

2.2.3.1 Survey and Collection Vessels. To meet the objective of collecting fallout and establishing contours over the vast ocean fallout areas, an extensive array of floating and flying instrument platforms was needed. The following summary lists these platforms, but the detailed discussion of the instrumentation aboard will be postponed to Section 2.3.

a. The GRANVILLE S. HALL (YAG-39); GEORGE EASTMAN (YAG-40); and the USS CROOK COUNTY (LST-611) were positioned in the fallout area prior to the arrival and served as completely instrumented collector stations.

b. Two large barges, the YFNB-13 and YFNB-29, and three pontoon rafts were anchored in Bikini Lagoon as fallout collection stations.

c. Fourteen to sixteen skiffs (the number varied with each shot) were moored in the deep ocean north of Bikini Atoll for fallout collection. In addition to the array of skiffs moored in the ocean north of Bikini Atoll, for ZUNI, one skiff was deep moored in the open ocean to the South of the Atoll and for TEWA, 3 skiffs were placed to the West of the Atoll.

d. Two destroyer escorts, the USS MOGINTY (DE-365) and USS SILVERSTEIN (DE-534), and the oceanographic research vessel M/V HORIZON ~~perm~~ were held out of the area until fallout ceased and then per- performed a radiological survey of the contaminated ocean areas. ~~after fallout had ceased.~~

e. An instrumented landing craft, the LCU-1136, performed a survey of the Bikini Lagoon after fallout from shots CHEROKEE, ZUNI, FLATHEAD, and DAKOTA had ceased. BEST AVAILABLE COPY

f. P2V aircraft surveyed the ocean areas after fallout had ceased, measuring the exposure rate in the air above the ocean.

g. On occasion the M/V HORIZON, DE's and P2V aircraft were used to check background radiation before a shot and the effects of ~~air and~~ water currents on the fallout ocean area.

2.2.3.2 Surface ~~Intensity~~ Exposure Rate Readings. A probe furnished by Project 2.62 was trailed in the water on a cable from a boom extending some 25 feet from the side of the YAG's and DE's and from the stern of the M/V HORIZON. The radiation sensing element was about three feet under

the surface of the water. The probe consisted of geiger tubes and battery packs encased in one-quarter inch wall steel tubing. Two sensing heads were designed for the probe, one for detecting low level radiation down to background and the other with less sensitive tubes to be used at levels as high as 100 r/hr. The data from the probe was recorded aboard the ship on a chart recorder. While surveying, the probe was towed and a continuous recording of exposure rate made.

Also mounted at the end of the boom ~~in~~ on the two YAG's was a Project 2.64 scintillation detector which was used to obtain readings of the radioactivity as observed looking down from approximately 25 feet above the surface of the water. This instrument utilized a plastic phosphor and covered a range from 0.01 to 1000 mr/hr. The current output, which was proportional to the logarithm of the exposure rate, was recorded on an Esterline Angus strip chart recorder.

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P2V aircraft were instrumented by Project 2.64 with a plastic phosphor detector and associated recording equipment to measure the exposure rate in the air above the ocean. These readings, whenproperly converted, correspond to the exposure rate in the surface water layer. The data was recorded in uncorrected form on a chart recorder. It was also corrected automatically to a surface reading and recorded on a magnetic tape. The sensing unit was shielded ~~to minimize the~~ effect of ~~contamination on the aircraft and the resulting angular response~~ was measured and the readings appropriately corrected.

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<u>2.2.3.3 Intensity Versus Depth Profile.</u> The probe described in Section 2.2.3.2 was also used to obtain exposure rate vs depth profiles. It contained a pressure sensing element to record the depth at which the instrument operates. The cable which supported the probe was a three conductor armored cable, so that the signals from the radiation and pressure sensing elements in the probe traveled up through the conductors and were recorded on an XY recorder aboard ship. The equipment for making depth profiles was designed for a maximum depth of 400 meters except on the M/V HORIZON where it could attain a maximum depth of 800 meters.

Penetration recorders designed to trigger upon arrival of fallout at the surface and to record the gamma exposure as a function of time thereafter at 20, 40, 60, 80 and 100 meters in depth, were installed on some of the deep moored skiffs.

<u>2.2.3.4 Analysis of Water Samples.</u> All survey ships were equipped to take surface water samples using polyethylene buckets lowered over the side. In addition, the M/V HORIZON was equipped to take samples at depths with standard Nansen bottles. Detailed analyses of these samples were then made by Projects 2.62, 2.63, and 2.64.

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<u>2.2.4 Radiation Readings in the Nuclear ~~Cloud~~ mushroom.</u> Project 2.61 undertook to measure the radiation in the nuclear ~~cloud~~ mushroom with pressure ion chambers borne by single stage rocket propelled atmospheric sounding vehicles (ASP). The exposure rate data was telemetered to essentially duplicate receiving-recording stations on the USS KNUDSON (APD-101) and

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2.2.3.5 Fallout Decay Tanks. In order to determine the ~~effective~~ decay of the fallout material in the ocean water as measured by the survey probe, a decay tank 6 feet in diameter and 6 feet deep was placed on the deck of the YAG 39. The tank was filled with ocean water before the arrival of fall-out and a probe was placed in it. The tank then collected fallout and was agitated to maintain a uniform distribution. The probe readings gave data on the buildup and effective decay of the activity.

A tank 5 feet in diameter and 5 feet deep was used on the deck of the M/V Horizon in a similar fashion. However, in this case, the tank was filled with contaminated ocean water as soon as it was obtainable after the M/V Horizon began making the oceanographic survey, which was after the fall-out in the area had ceased. To prevent the fallout particles from settling out or adhering to the sides of the tank, the water was treated with sodium silicate and hydrochloric acid to form a gel as soon as possible after it was obtained. The "gelling" was not completely successful and the water was also mixed mechanically. Readings from the probe in this tank then gave data on the decay.

Site NAN where the signals were recorded on magnetic tape. Figure 2.1 is a picture of an ASP on its launcher. This rocket is 6 1/2 inches in diameter and 147 1/2 inches long. On the shots CHEROKEE, ZUNI, and NAVAJO, two salvos of six rockets each were fired from the launchers near the center of HOW Island. The first salvo was fired commencing at H+7 minutes and the second salvo was fired at H+15 minutes. Four rockets were fired in one salvo at H+7 minutes on shot TEWA. The rockets were fired along trajectories which would best give data on the relative activity in the cloud and stem and the distribution of activity in each of these. Trajectory data as shown in Figure 2.2 from a limited number of previous firings of the ASP were used to calculate the position of the rockets in the cloud as a function of time for the predetermined elevation and azimuth of the launcher.

In addition, Project 2.66 manned aircraft were flown into the radioactive cloud as early as H+15 minutes on certain shots and obtained further data on the distribution of activity in the cloud.

2.3 OPERATIONS

2.3.1 Land Stations. The location of the land stations at Bikini Atoll are shown in Figure 2.3. All instrumented islands had both incremental and gross collectors. Figure 2.4 is a picture of a representative Project 2.65 land station. From three to five days before each shot were required for preparing and checking the instrumentation at the stations. The samples from the stations were recovered after each shot as soon as radiation levels permitted. Some preliminary analyses of samples were

PROPELLANT.........Single grain GCA201A stabilized ammonium perchlorate oxidizer and LP33 thiakol base.

TOTAL IMPULSE......31,000 pound-seconds.

BURNING TIME.......5.8 seconds.

WEIGHT.............Pre-launch - 245 pounds.
Burn-out - 100 pounds.

MAXIMUM VELOCITY..~5,000 feet/second.

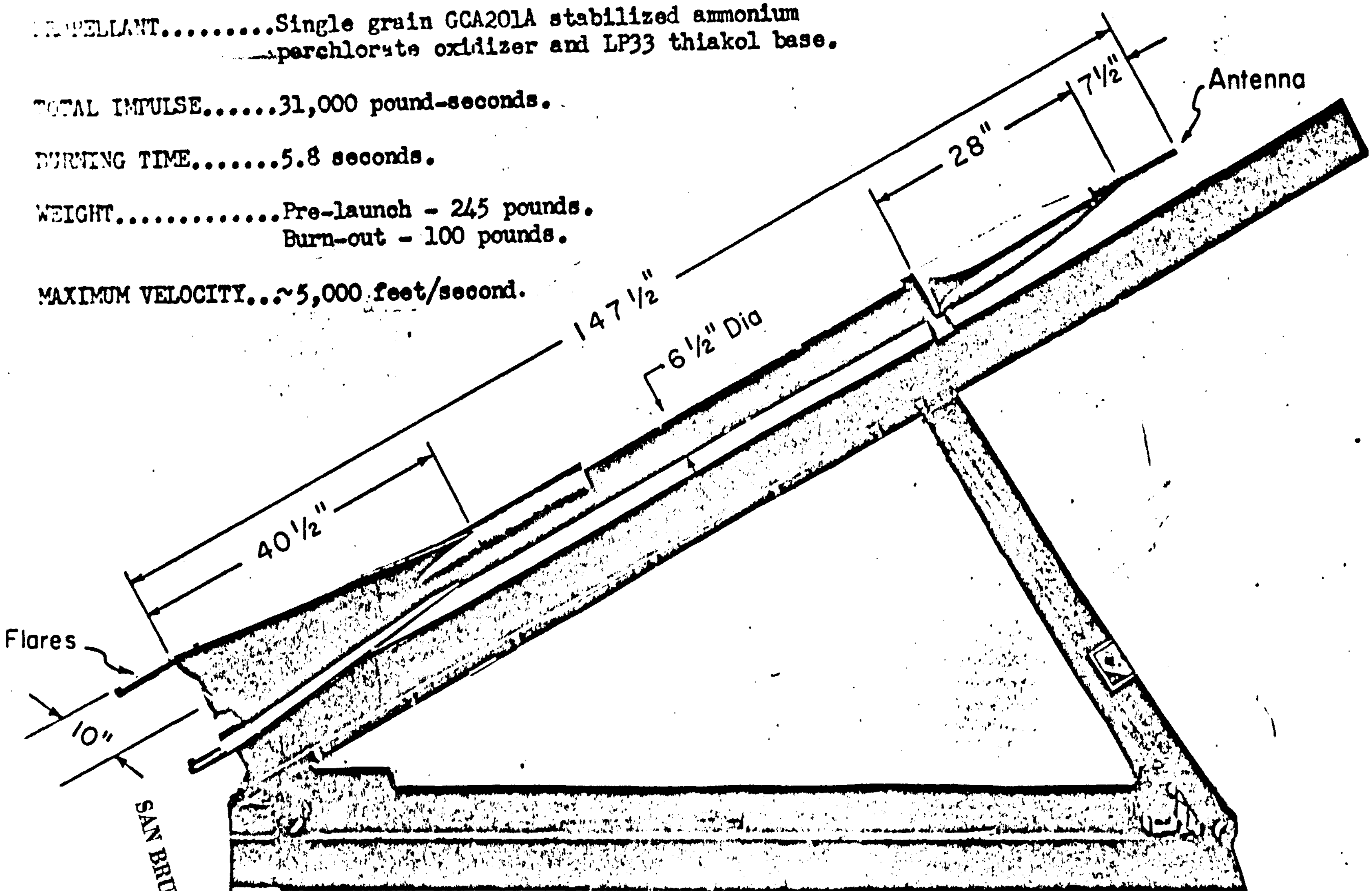

Figure 2.1 Project 2.61 A3P rocket on launcher.

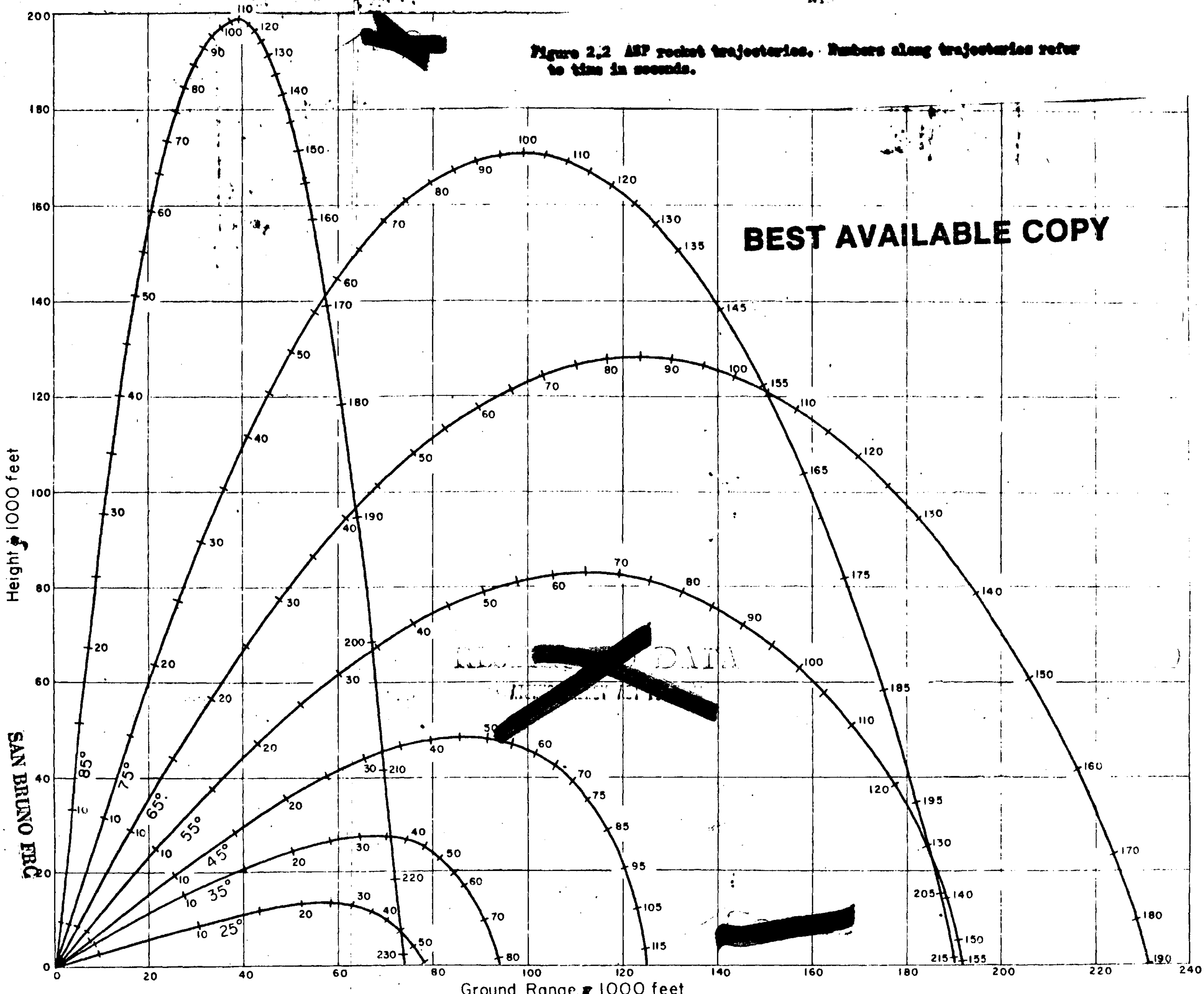

Figure 2.2 ASP rocket trajectories. Numbers along trajectories refer to time in seconds.

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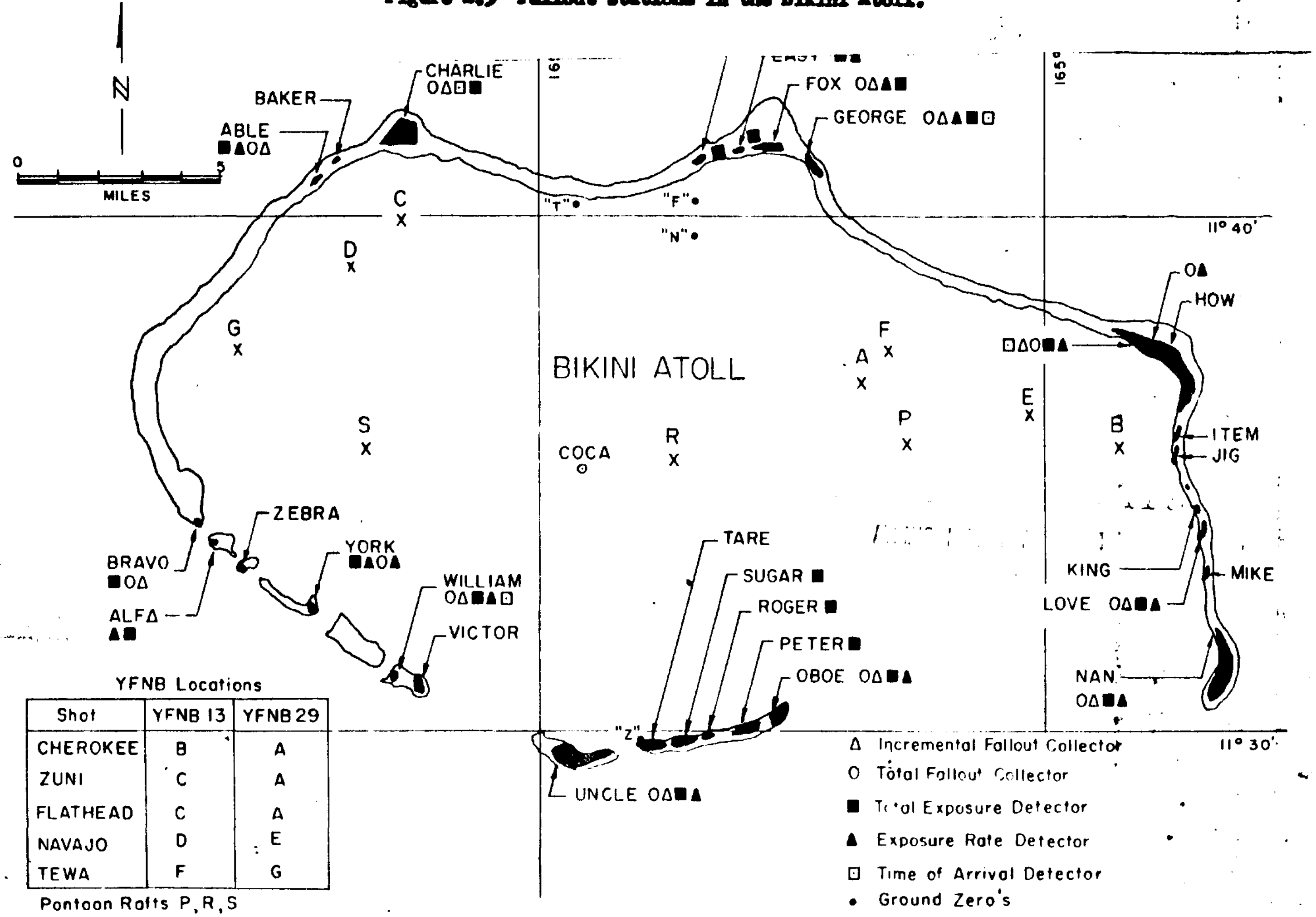
Figure 2.3 Fallout stations in the Bikini Atoll.



YFNB Locations

Shot	YFNB 13	YFNB 29
CHEROKEE	B	A
ZUNI	C	A
FLATHEAD	C	A
NAVAJO	D	E
TEWA	F	G

Pontoon Rafts P, R, S

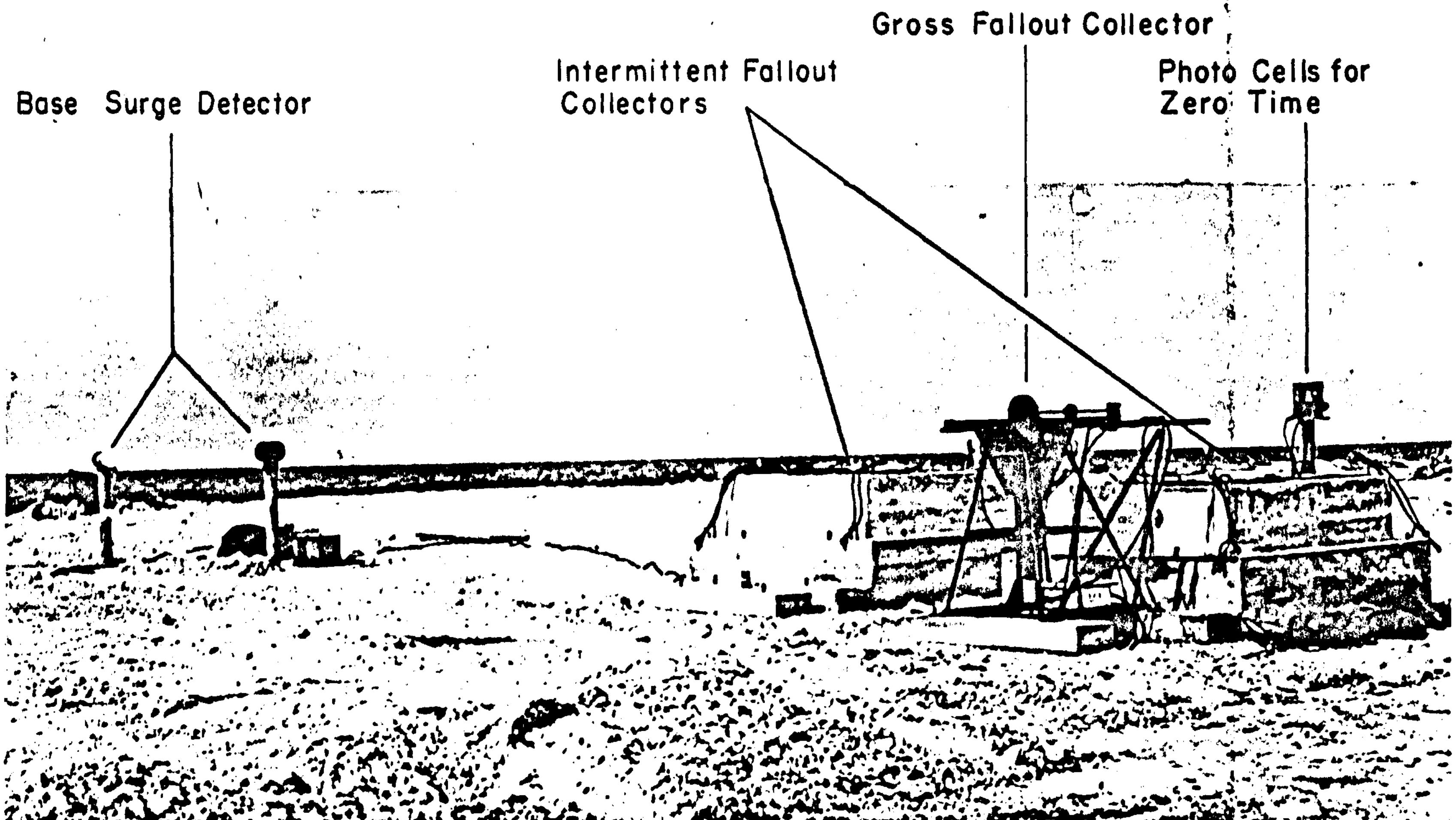


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Figure 2.4 Representative land station of Project 2.65 on Site OBOE.

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made at Site FLUTE and the remainder of the samples were placed aboard the fly-away aircraft for complete analyses in laboratories in the United States.

2.3.2 Moored Stations (YFNB Barges, Rafts, and Skiffs; see Figures 2.3 and 2.5 for locations). Two YFNB barges were anchored in Bikini Lagoon at positions which varied with shot location. These barges were completely instrumented by Project 2.63 with equipment for collecting fallout material and recording radiation readings in both incremental and total form. In addition other projects placed equipment aboard for correlation.

YFNB-29 had one instrument tower at each end of the barge. The towers were separated by a distance of 250 feet which was considered to be far enough apart to indicate the extent of variation of the fall-out within a small region. Three pontoon rafts (each 15 feet by 16 feet) were placed at positions as shown in Figure 2.3 for all shots. Instrumentation for time of fallout arrival, total collection of fall-out material, and total exposure reading were placed on these rafts.

Skiffs were deep moored in the ocean north of Bikini Atoll as shown in Figure 2.5. Each skiff contained the same general type instrumentation as was placed on the rafts. However, in addition, penetration recorders were placed on some skiff installations. Figure 2.6 shows the detail of a skiff station. Beginning two to three days after a shot the USS SIOUX was used to recover the skiffs, collect the samples and data, and re-arm the skiff for the next shot.

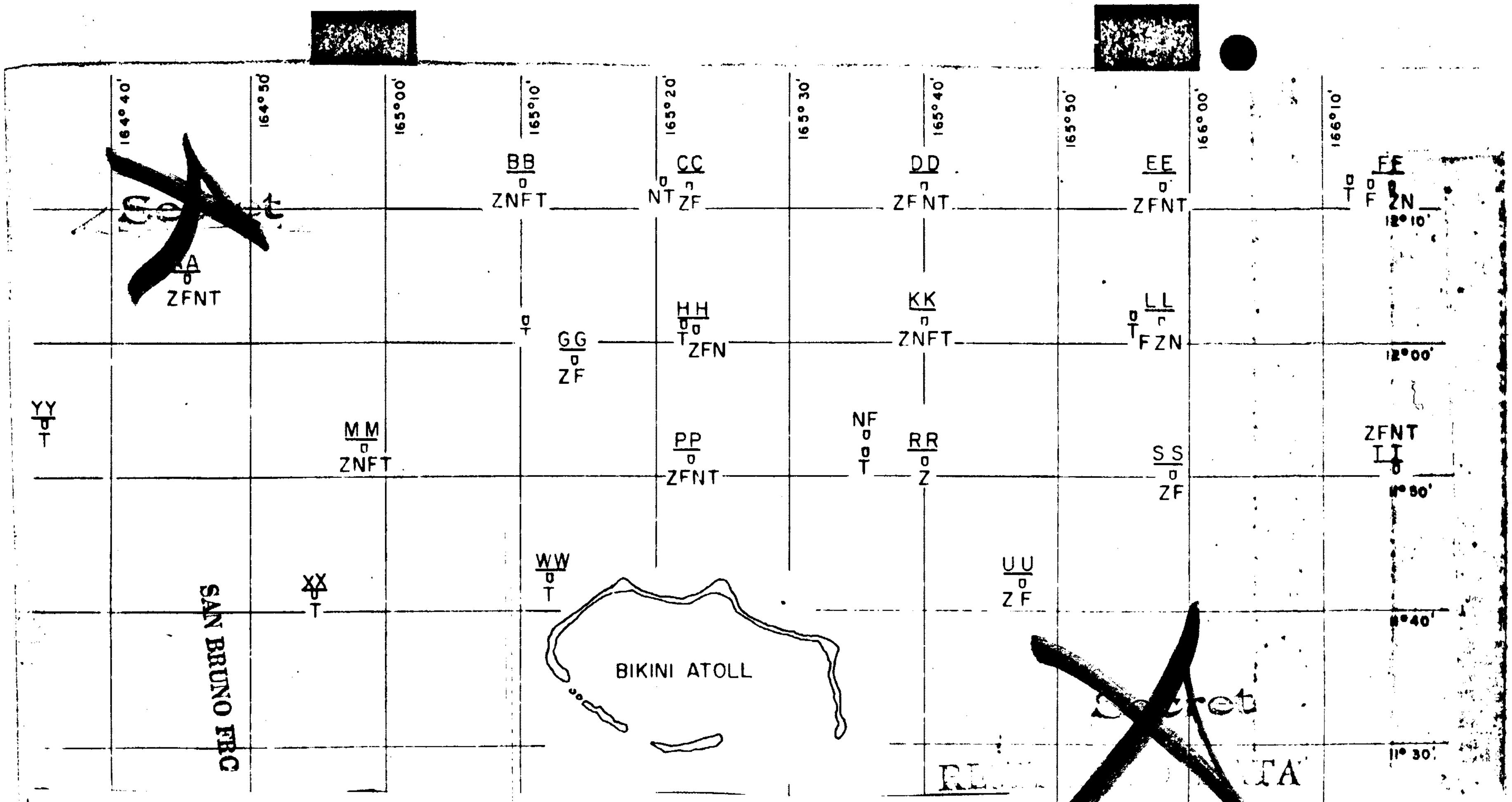

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Figure 2.5 Skiff array. Underlined letters are the position designator. Z, F, N, and T correspond to locations for shots ZUNI, FLATHEAD, NAVAJO, and TEWA respectively.

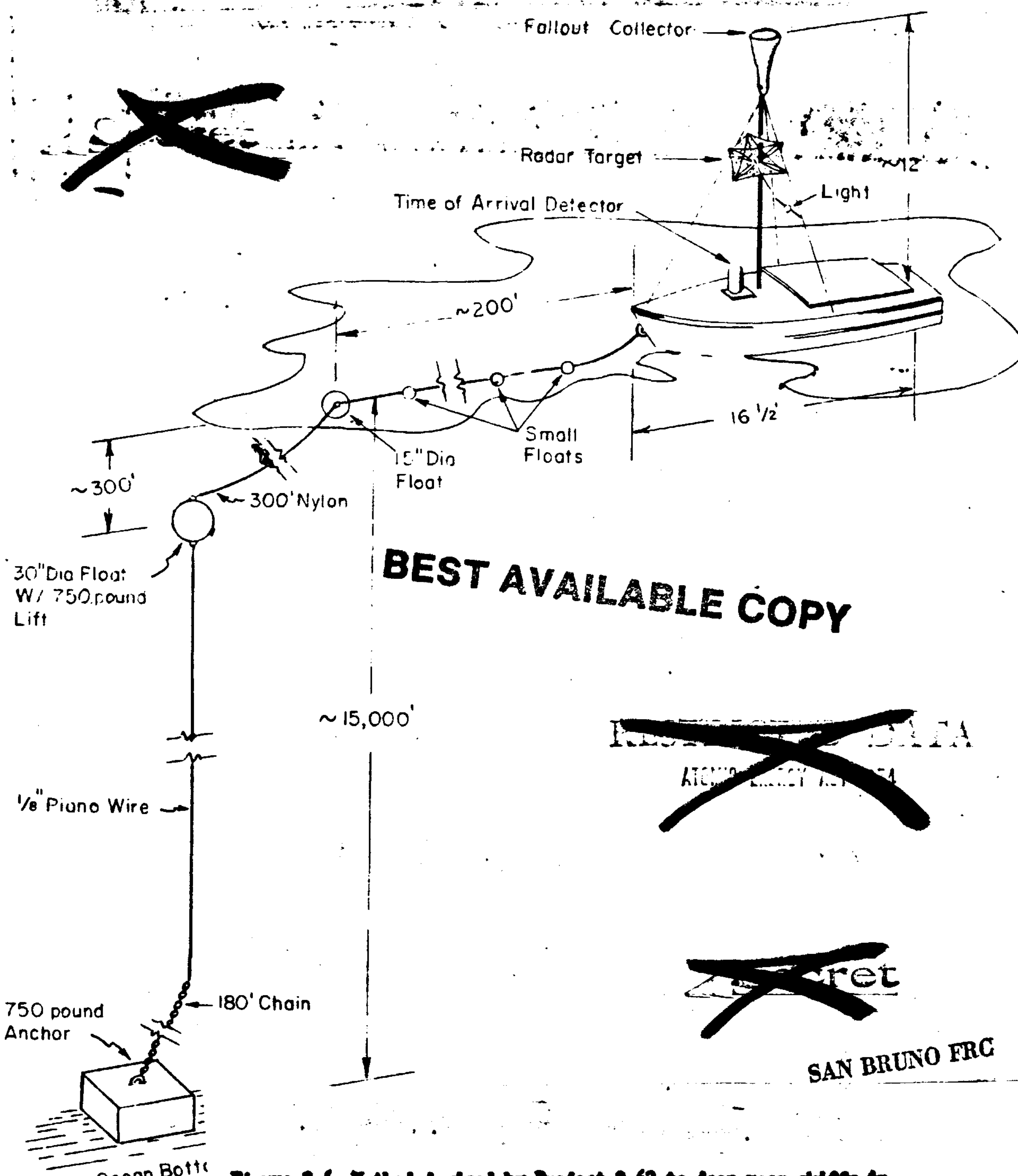

Figure 2.6 Method devised by Project 2.62 to deep moor skiffs in open ocean.

2.3.3 YAG's and LST. The YAG-39, YAG-40 and LST-611 were the most completely instrumented stations in the fallout program. The vessels were designed so they could be maneuvered into key positions in the fallout area for each shot. They were directed to such positions by calculations based on known and predicted wind data. These vessels ~~were~~ performed equivalent functions to land collection stations and were necessary because of the very limited land areas at the PPG. These ships were manned and when fallout arrived, the small crew went to a shielded room in each ship and controlled the ship from there. The fallout instrumentation was designed to be operated from this control room and much of the data was recorded there. Figure 2.7 shows the details of the instrumentation on the YAG's. A shielded laboratory was installed on YAG-40 to make very early measurements on decay, spectrum, etc. of the fallout material.

2.3.4 P2V Aircraft and Helicopters. P2V aircraft equipped with scintillator detectors flew at altitudes from 200 feet to 400 feet over the water areas soon after fallout was complete. On shot day, aircraft surveyed the areas near Bikini Atoll after the fallout was down in these areas. On succeeding days, one or more planes surveyed the ocean area farther out as fallout ceased. Prior to shots NAVAJO and TEWA, a P2V aerial survey was made of the area to the west of Bikini to check the area of radioactive effluent from the Bikini Lagoon.

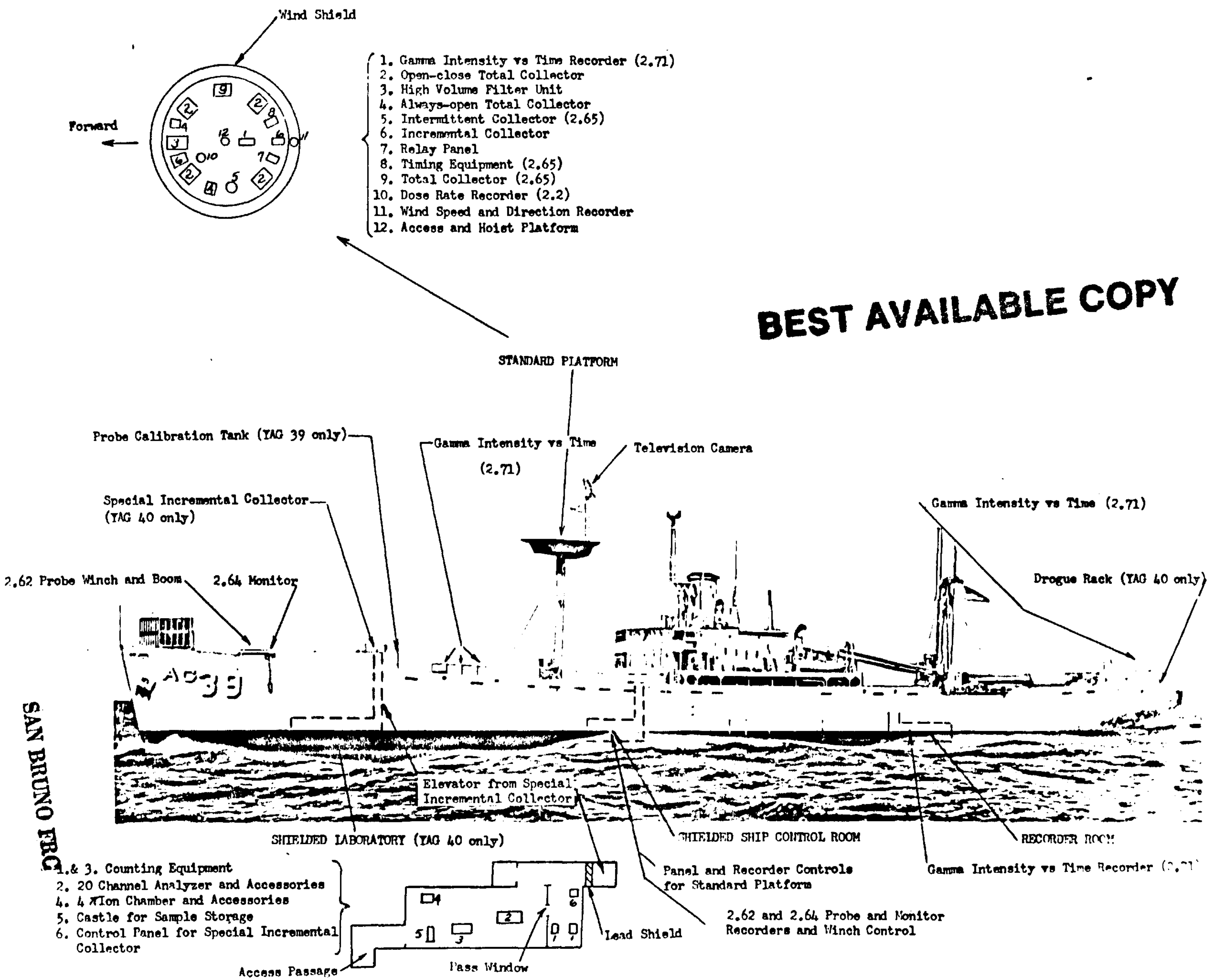

Figure 2.7 ~~USNS~~. GRANVILLE S. HALL, YAG 39. Fallout collection stations are for Project 2.63 unless otherwise noted. Ship operation was under the direction of Project 2.10.

Radiation exposure rate measurements on land surfaces were made by using a probe attached to a cable and lowering the probe from a helicopter to the ground. Figure 2.8 shows some of the details of how these measurements were made. The helicopter hovered over the island at altitudes from 500 to 1,000 feet and therefore this technique permitted very early measurements to be made without excessive radiation dosage to personnel.

<u>2.3.5 Two DE's, M/V HORIZON, and LCU-1136</u>. While the YAG's and LST were located at key positions in the fallout pattern at the time of fallout, the two DE's, M/V HORIZON, and LCU-1136 were not directed into the pattern until the fallout was complete. Once the fallout had ceased, the two DE's were dispatched into the area to make passes across it and establish the boundaries of the fallout pattern as well as to make a detailed survey of the pattern within these boundaries [illegible]. The M/V HORIZON was a slower vessel and made a somewhat more detailed oceanographic survey in the fallout area and thus complemented the more rapid surveys of the two DE's. The LCU-1136 made oceanographic type surveys of Bikini Lagoon while the other three vessels covered the vast areas of the fallout in the ocean after the five shots of interest to the fallout program. All of the survey vessels made surface and depth profile measurements of the activity and collected water samples. Just prior to NAVAJO, an oceanographic survey was made to determine background activity which might mask the low levels anticipated from this shot.

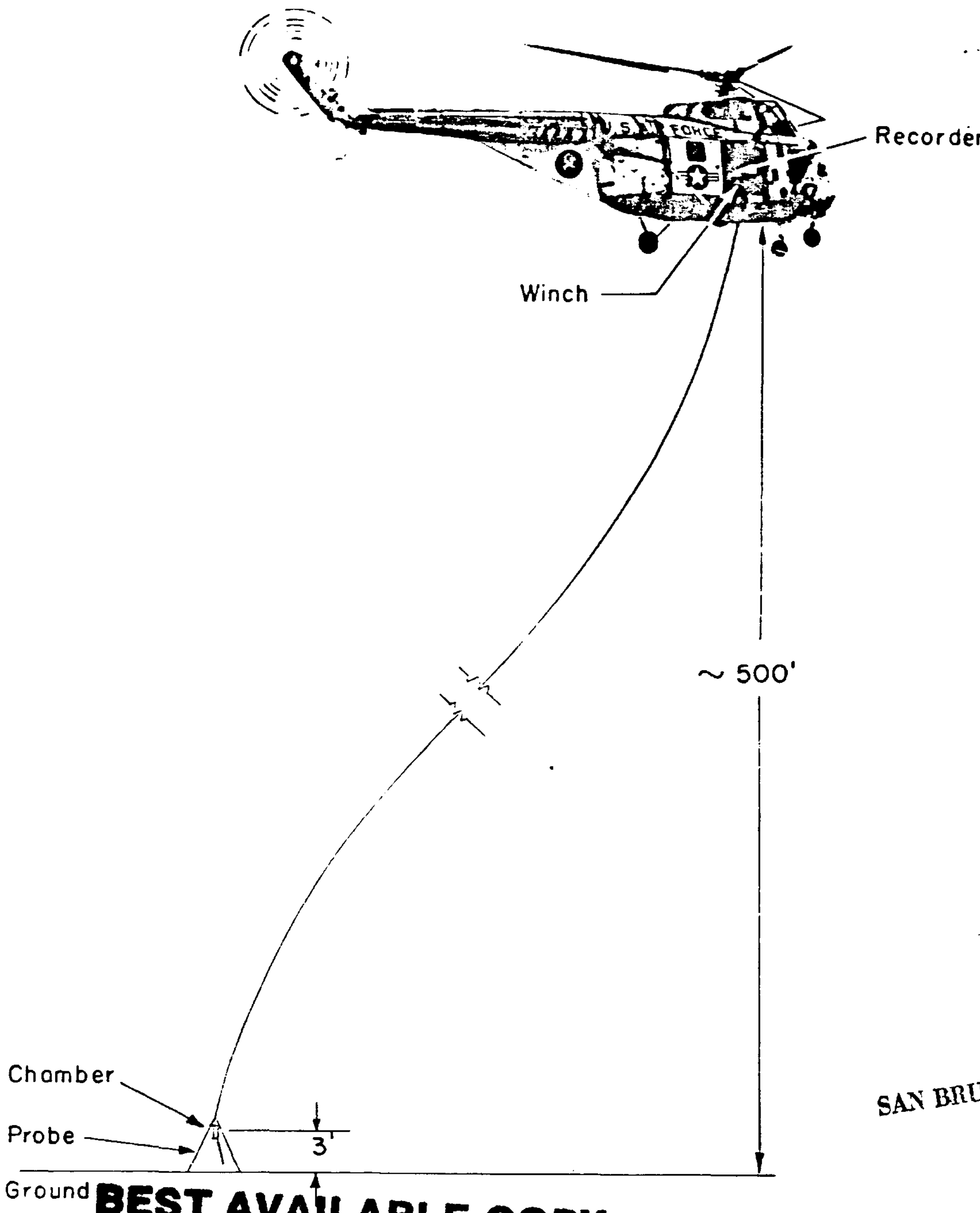

Figure 2.8 Arrangement of Project 2.65 probe for measurement of gamma dose rates.

2.3.6 Program Two Control Center. The Program Two Control Center was located in the Flag Communications Center aboard the Task Force SEVEN Command ship, the USS ESTES. The primary reason for locating the Center here was the availability of communications required for contact with the ships and aircraft.

Meteorological data and predictions were obtained and on the basis of these a ~~static~~ particle fall plot was constructed for the H-hour wind predictions. Work on these plots was begun on D-1 when the first ship was directed into the area where fallout was expected. This plot was revised as later meteorological data and predictions were received. A constant revision of the plot was necessary since the LST and the two YAG's had to leave the Bikini Lagoon on D-1 in order to arrive at locations in the predicted fallout area. The time variation of the winds also resulted in minor changes in the positions of the YAG's and LST-611 being made after shot time in order that the ships be in the most favorable locations when fallout arrived. Direct communications between the Program Two Control Center and the project ships permitted the desired close control on the positioning of the ships.

The P2V aircraft, based at Kwajalein, began their survey around Bikini Atoll on shot day. From the Control Center they were given instructions regarding their flight paths over the area, as far as possible avoiding regions where fallout might still be coming down.

Once the general area of close-in fallout was delineated by the P2V aircraft, the two DE's and the M/V HORIZON were directed into this area to begin an oceanographic survey, and the LCU-1136 began a survey of Bikini lagoon.

By relaying to the ships successive courses and points to which to proceed and receiving reports from the ships on their speed and position fixes, a detailed plot of the trace of each ship was maintained in the Control Center. A similar plot was maintained for the flights made by the P2V aircraft.

Fallout data from the various ships and aircraft were reported directly to the Program Two Control Center. Here the information was recorded in data books by the various projects and also placed on a Master Operations Plot. In addition to the data obtained from the ships and aircraft, radiation readings on the islands in Bikini Atoll were obtained from the group performing the atoll aerial survey and from the Task Group 7.1 RadSafe organization. These data were also recorded on the Master Operations Plot.

The Control Center continued in operation for as long as five or six days after an event while the survey ships were completing their detailed oceanographic survey of the fallout area.

2.3.7 Correlation Measurements. The instrumentation was very carefully correlated between the various projects. Project 2.65, which had fallout collection and radiation reading instrumentation at land stations, placed the same type of instrumentation aboard the two YAG's and

one of the YFNB barges. Similarly, Project 2.62, which designed the instrumentation aboard the two YAG's, LST, and YFNB barges installed a major land station at the northern tip of HOW Island for cross calibration. This station consisted of a tower containing a major array of instrumentation very similar to the instrumented towers on the YAG's, LST and YFNB barges.

CHAPTER 3

RESULTS

3.1 THE LAND SURFACE BURST

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3.1.1 Zuni.

3.1.1.1 Introduction. The Zuni Shot was fired at the surface of Site Tare on 28 May 1956, at 0556M. The yield of the weapon was measured to be approximately [redacted] of which [redacted] It has therefore been assumed that all radiation readings presented for fallout from this device should be

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These values form the basis for comparison between [illegible]

The environment of the Zuni weapon is illustrated in Figure 3.1 on which is also drawn the outline of the crater formed by the detonation. Clearly a large fraction of the crater was in land and reef, although a part of it extended into the deep lagoon water. Zuni was considered as a land surface shot, although the proximity of the deep lagoon introduced minor modifications which may make it similar to a shallow harbor burst.

3.1.1.2 Distribution of Activity in the Stabilized Cloud. Measurements of the radiation field at various positions in the nuclear cloud were made at H+7 minutes and H+15 minutes by the Project 2.61 rockets. The exposure rate data as recorded on magnetic tape have been subjected to preliminary analysis. The preliminary reduction of this data to information concerning the distribution of active material in the cloud is subject to the following limitations:

(a) The read-out circuit is not as elaborate and free from noise interference as that to be used in the final analysis.

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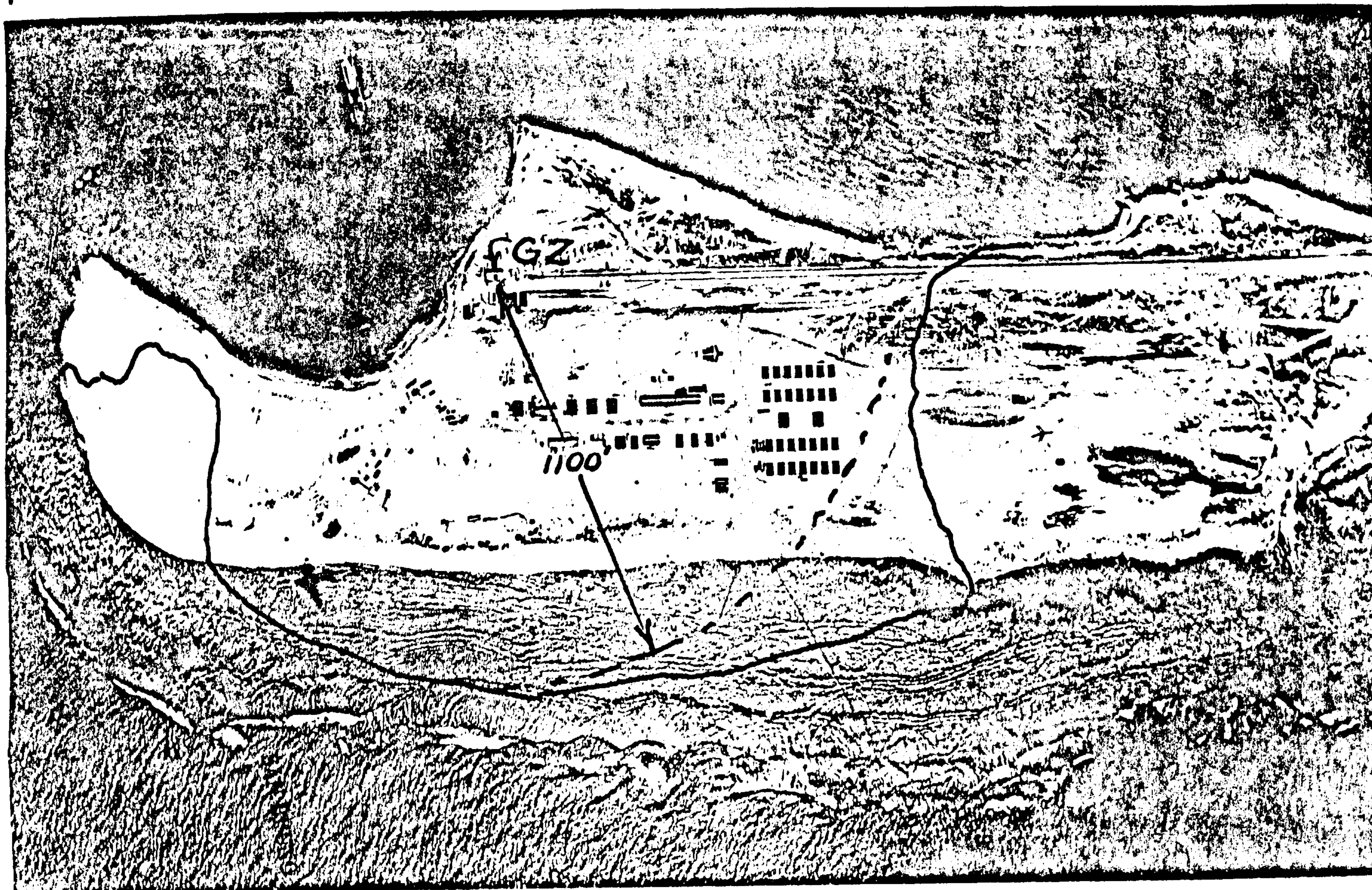

Figure 3.1 Aerial View of Site Tare With Overlay of the Zuni Crater.

(b) The identification of a particular rocket track with a known exposure rate versus time record is quite certain for some traces, but not in the case of others. However, the main conclusions to be drawn from the data will probably be insensitive to the exact identification of all the traces.

(c) The rocket trajectories are based on the data available in the field and may be improved by subsequent analysis of data from test firings.

(d) The calibration of the ion chamber detectors at high exposure rates is not linear and such readings may have to be altered using better calibration curves.

(e) There is some uncertainty in the zero time on a number of records as related to the launch time of the rockets.

It is desirable to present the data in such a form that it demonstrates the concentration of source activity at various positions in the cloud. The exposure rate readings at a particular location actually represent the cumulative effect of many sources distributed over a volume whose dimensions are of the order of the attenuation length for the gamma rays. This attenuation length is inversely proportional to the density of the air and varies from about 400 feet at sea level to 1,400 feet at an altitude of 40,000 feet, and to 10,000 feet at an altitude of 80,000 feet. Therefore, the observed exposure rates actually measure average distributions of activity over volumes having the given dimensions. Since these volumes, particularly near the bottom of the cloud, represent a small part of the total cloud volume, this method of

measurement of the activity is meaningful. In presenting the data, the observed exposure rate readings were multiplied by the ratio of the air density at the data point to the sea level density. The result represents the exposure rate that would have been observed had the same density of sources been present in air at sea level pressure and temperature, and therefore is proportional to the activity concentration. A crude calculation predicts that a distribution of 1 curie/m^3 under these conditions would produce an exposure rate of about 1,200 r/hr.

Subject to the limitations discussed above, the reduced exposure rate readings are presented in Figures 3.2 and 3.4 for the 7 and 15 minute salvos respectively. The mushroom outline presented is a cross-section in the plane of the rocket trajectories which has been constructed on the basis of the assumption that the cloud and stem move from zero time to rocket firing time under the influence of the measured H-hour winds. Figures 3.3 and 3.5 represent views along the rocket trajectories which indicate where the plane of the trajectories intersected the cloud and stem. The assumed mushroom dimensions are illustrated in the inset in Figure 3.2 which represents a mushroom undisturbed by wind motion. The cloud was constructed by scaling up the dimensions of some photographs of the Dakota cloud [redacted] guided by visual observations and size versus yield data from previous operations (Reference 10).

Further data is also available from the Project 2.66 aircraft penetrations, but these were taken at appreciably later times. The observed exposure rate readings have been extrapolated to H+15 minutes using a $t^{-2.0}$ expression[1/] as determined by previous aircraft penetrations into

1/ The measurements performed at Operation REDWING indicate an exponent of 1.7 to be more appropriate. However, 2.0 has been used in this report.

Figure 3.2 Zuni Cloud at H+7 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.

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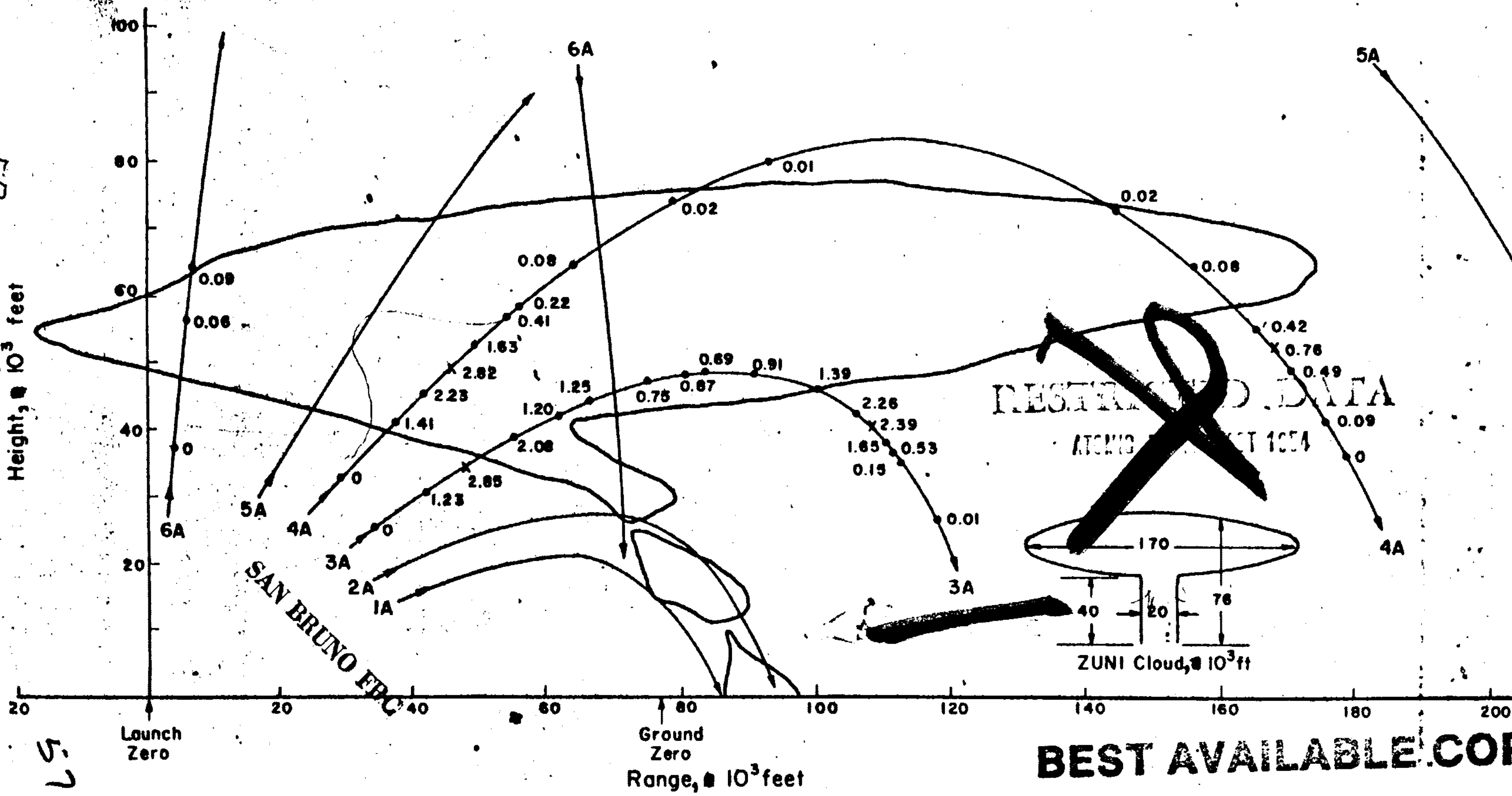

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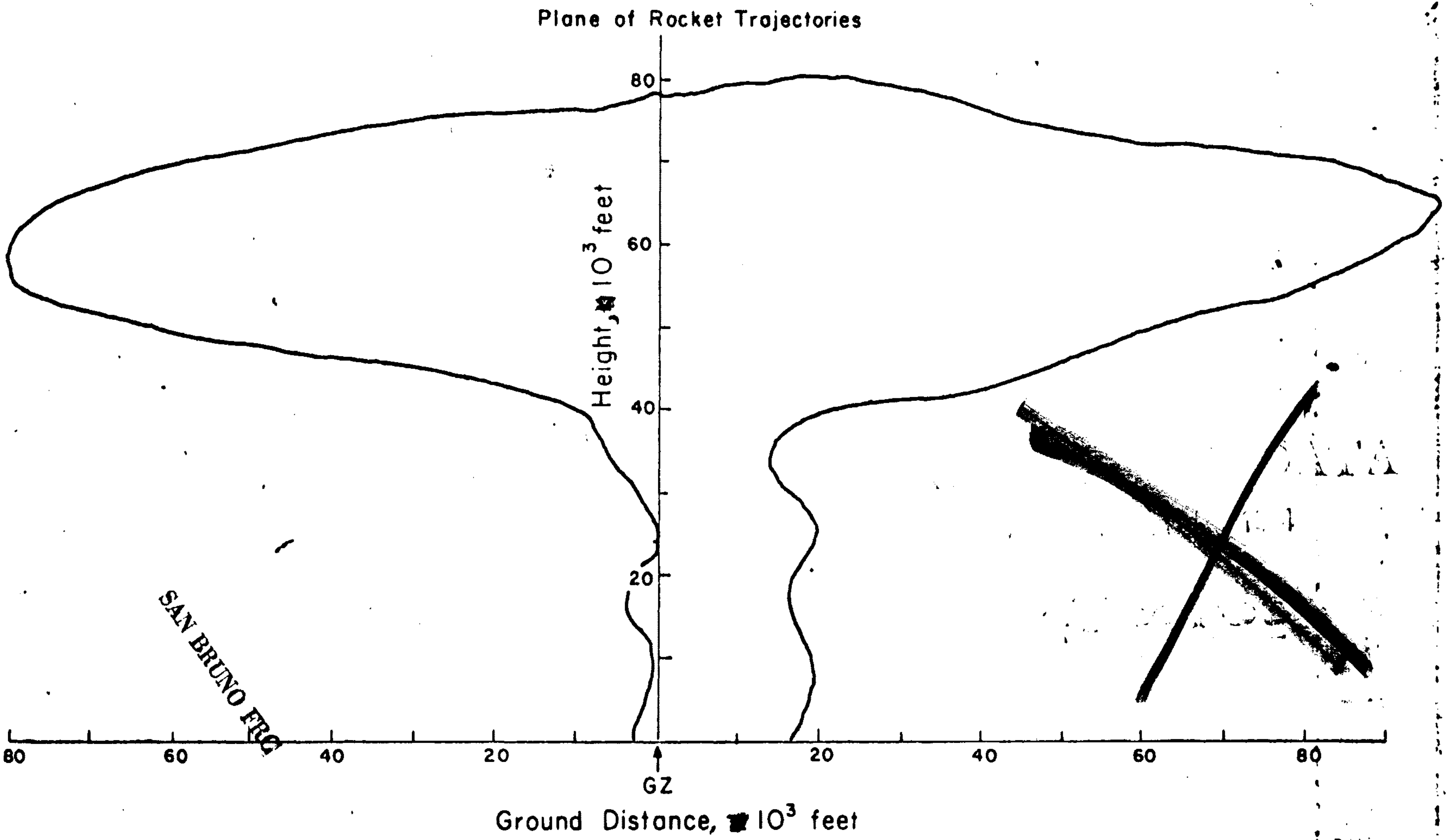


Figure 3.3 Looking Along Plane of H+7 Minute Rockets Toward Zuni Cloud.

Figure 3.4 Zuni Cloud at H+15 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.

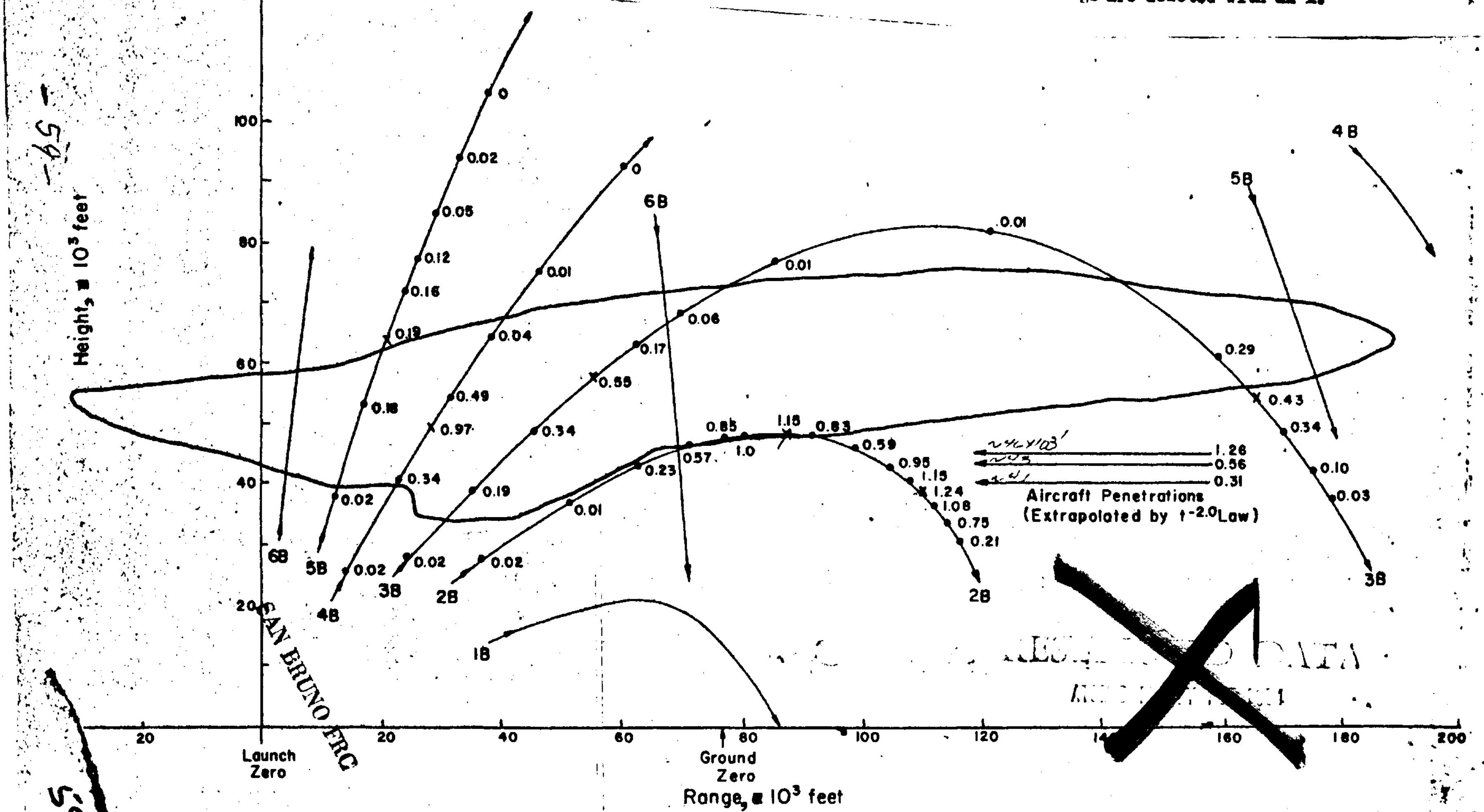
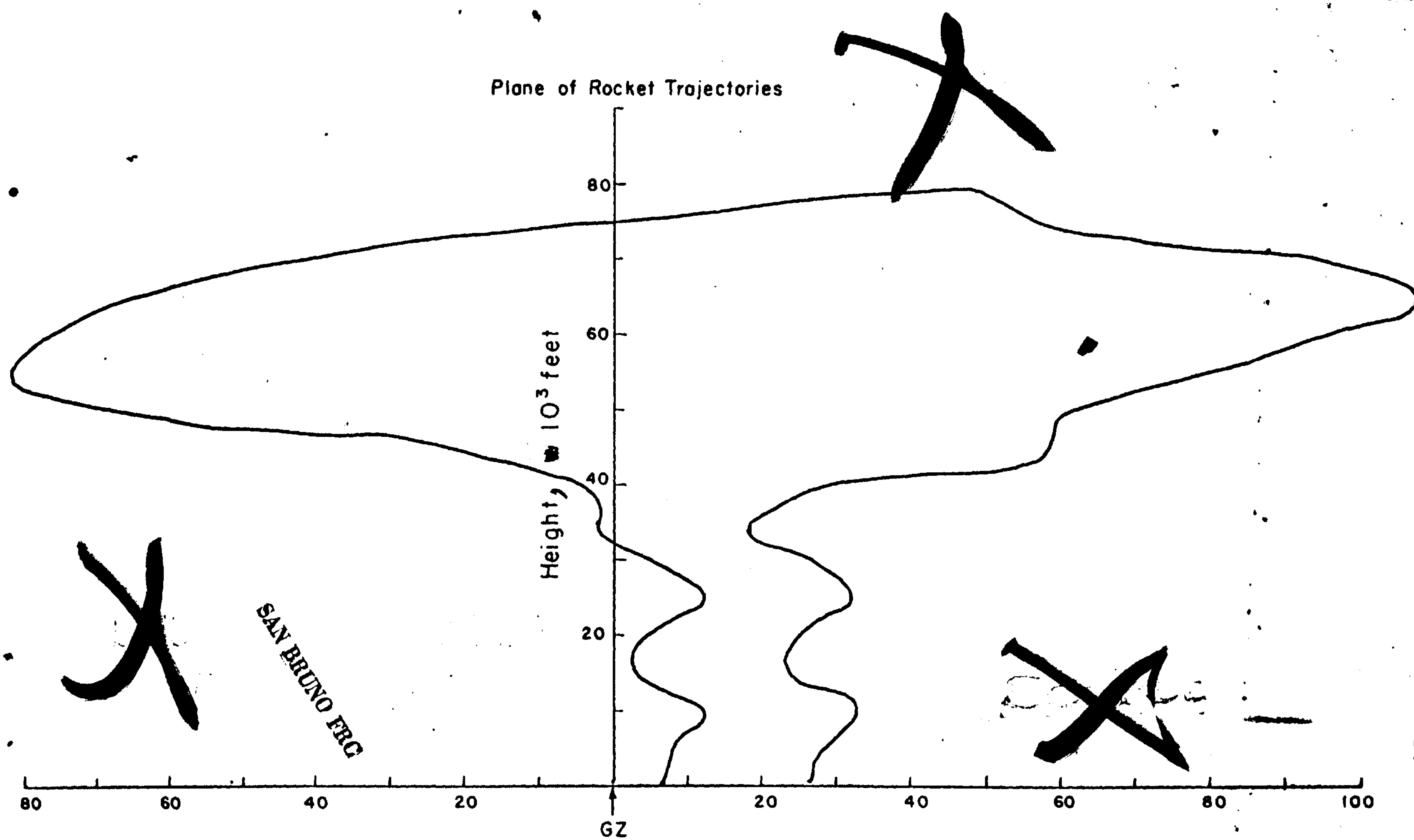


Figure 3.5 Looking Along Plane of H+15 Minute Rockets Toward Zuni Cloud.



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the mushrooms from somewhat lower yield detonations. These readings have been included in Figure 3.4, but must be considered tentative subject to uncertainties in the decay factors and the aircraft position relative to the main cloud.

3.1.1.3 Particle Fall Plot. (See Appendix B.) Figure 3.6 represents the particle fall plot for the winds measured at and after shot time for the Zuni event. This plot represents the position on the surface at which a particle would arrive if it originated at a given altitude above surface zero. The plot has been constructed taking into account the time and space variation of the wind pattern, but is subject to the following limitations:

(a) The continuous vertical line source above ground zero was approximated by increments at 5,000 feet levels.

(b) The wind velocity at a 5,000 feet level was assumed to represent the average velocity in the 5,000 feet interval centered at that level.

(c) The particles were assumed to drift with the local wind and to fall as governed by gravity and a typical air density and temperature versus height structure.

(d) The effect of vertical air motions on particle fall rates has been neglected.

(e) The space variations of the wind profile were deduced by a cursory examination of the Eniwetok and Rongerik winds and the synoptic charts which were constructed twice daily. A more detailed meteorological analysis of the air motions would probably introduce some slight modifications.

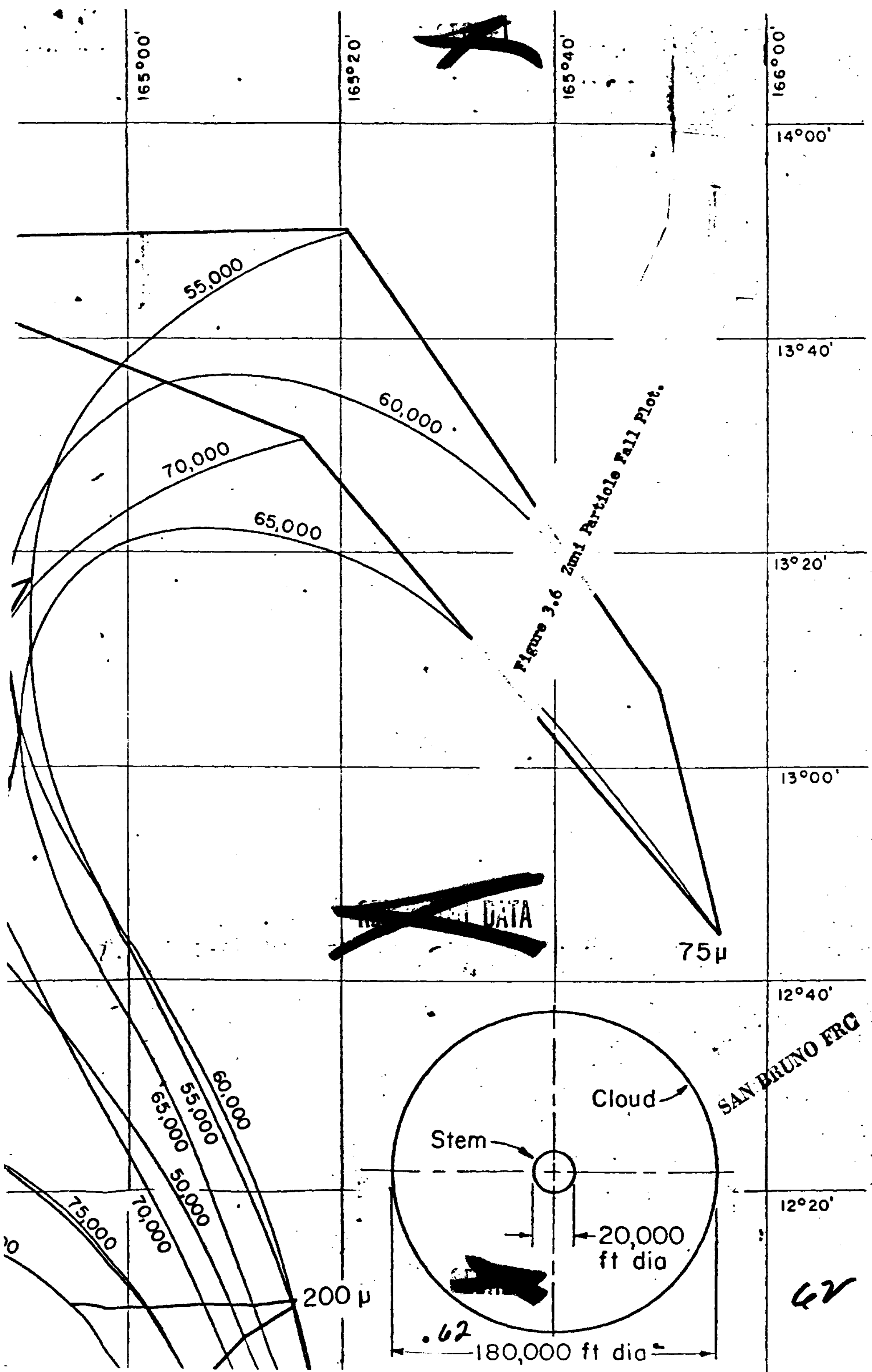

Figure 3.6 Zuni Particle Fall Plot.

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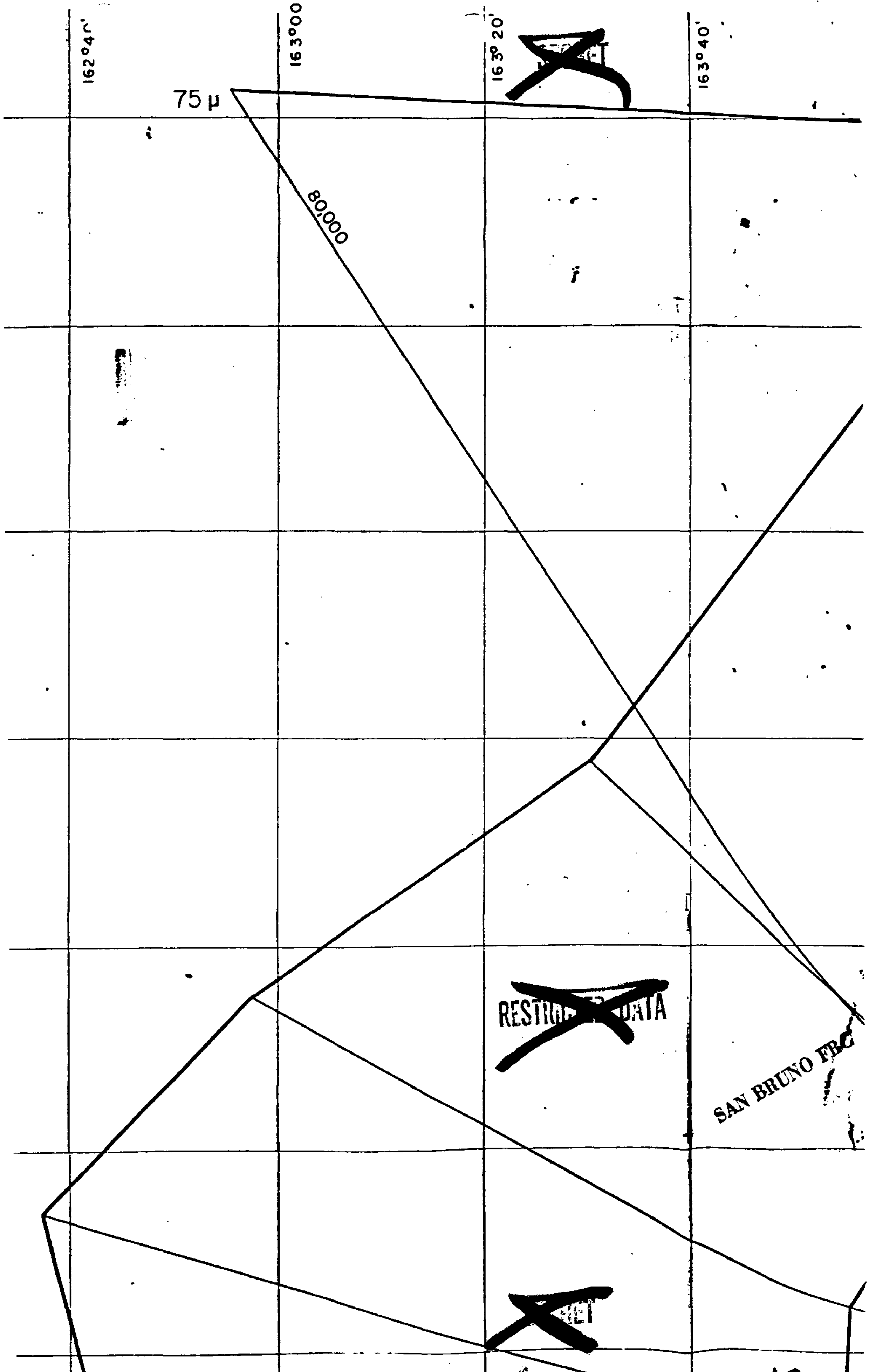

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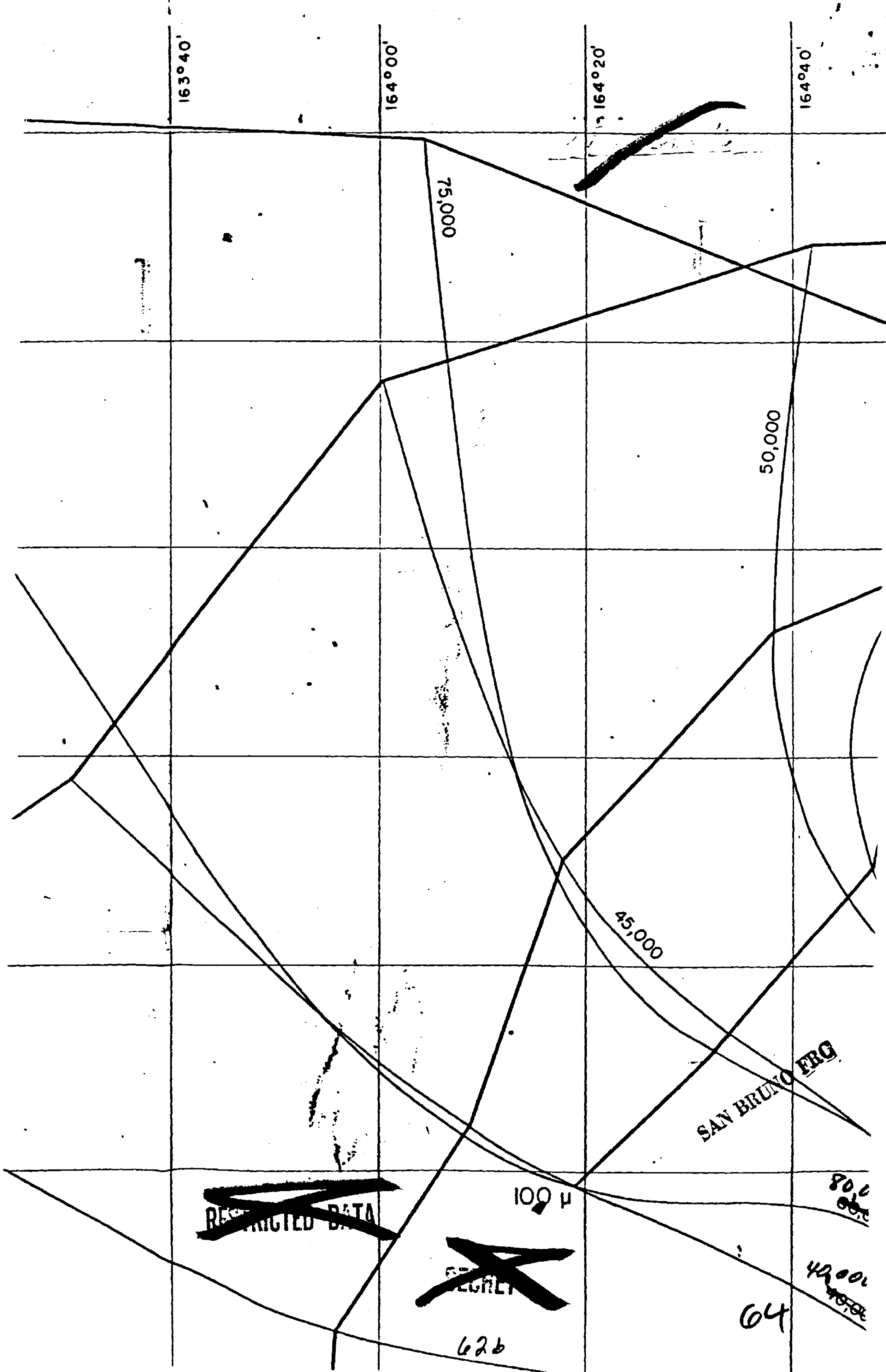
TOP



163°40'
164°00'
164°20'
164°40'
75,000
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100 μ
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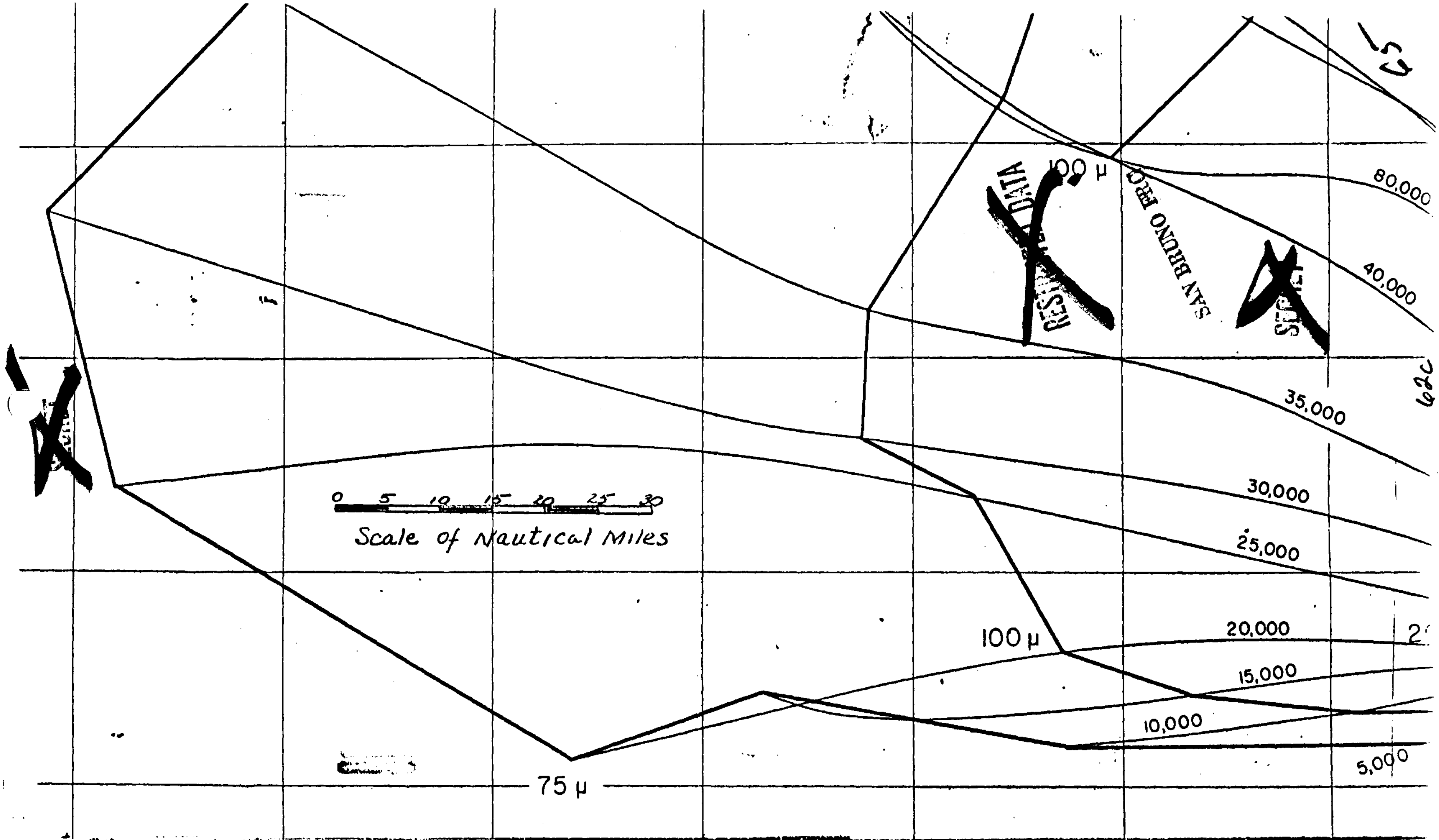
62b


0 5 10 15 20 25 30
Scale of Nautical Miles
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100 µ
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30,000
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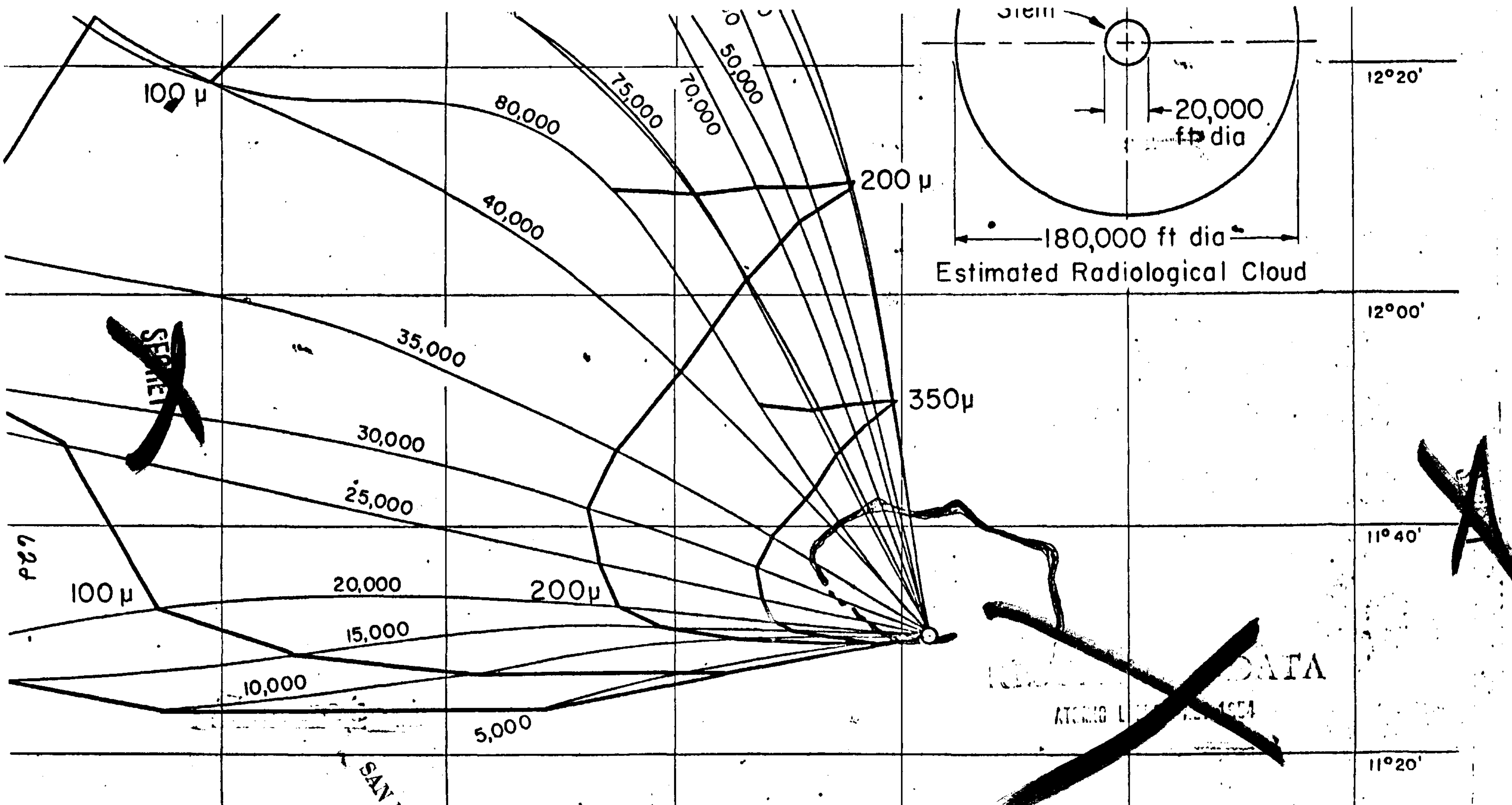
80,000
DATA
62c
65



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Any correlation of this plot and the actual fallout pattern must take into consideration the large horizontal dimensions of the initial cloud. Namely, a particular point on the ground may receive material not only from the particular size-height numbers associated with that point but from all such number pairs which fall within a cloud radius of that point. For reference, the estimated cloud and stem diameters are given as an insert to Figure 3.6.

One other effect can also influence the fallout pattern and is not easily predictable. The effective size of a particle can change as it falls.1/ This change is usually effected as condensation or evaporation of water and can manifest itself in one case as a concentrated radioactive region from local rain-out of material which would normally have been distributed over a large area.

3.1.1.4. Characterization of Fallout Material. The following general conclusions were drawn from the preliminary fallout analysis of Project 2.65:

(a) Two types of particles appeared at Site Bravo; a white irregular coral particle and an almost perfect sphere, the former being most abundant. The coral particle consisted of $CaCO_3$ with some CaO and $Ca(OH)_2$, and the spheres were mostly CaO or $Ca(OH)_2$ with a surface coating of $CaCO_3$.

(b) Radioactivity was distributed throughout the volume in the most active particles and only a few large particles showed a surface deposit of active material. The average activity per particle for the spheres was roughly ten times as great as for the coral particles.

1/ In this treatment the word "particle" is assumed to include droplets.

(c) The most abundant particle size at the size at the various stations were as presented in Table 3.1.

TABLE 3.1 PROJECT 2.65 PARTICLE SIZE AND PERCENT OF TOTAL sample ACTIVITY

Station	Particle Size (microns)	Percent of Total sample Activity
Bravo	210-420	12
	420-840	54
	840	19
Charlie	44-74	16
	210-420	25
	420-840	24
	840	10
Yoke	44-74	10
	210-420	12
	420-840	42
	840	15
YAG 40	44-74	12
	74-105	16
	105-149	14
	149-210	36
	210-420	15

Note: Only fractions contributing 10 percent or more of the activity have been included in this table.

(d) The apparent capture to fission ratio as derived by measuring the N_p^{239} and M_o^{99} activities varied markedly from sample to sample. The liquid samples were deficient in N_p^{239} by a factor of 10-100 as compared with the solid samples. The apprent capture to fission ratio varied for different particle size fractions between 0.44 and 1.54 for the Site Bravo sample and between 0.66 and 1.52 for the YAG 40 sample. The same analysis performed on a cloud sample provided by UCRL yielded a ratio of only 0.121. The ratio reported by UCRL for the cloud samples was 0.36.

At present it is not possible to evaluate the cause of these variations.

The Project 2.63 laboratory aboard the YAG 40 studied some individual particles and arrived at the following preliminary conclusions:

(a) The fallout material was very similar to that resulting from the Bravo shot at Operation CASTLE. The most predominant particle types were solid, irregular chunks and snowflake type of agglomerates. A very few white spherical particles were also present. The material appeared to consist of $Ca(OH)_2$ for the most part.

(b) On the basis of very preliminary data, the agglomerates appeared to be more active than the chunks.

(c) More detailed information was not available until the continental laboratory analyses were complete. **BEST AVAILABLE COPY**

3.1.1.5 Land Equivalent Distribution of Fallout Material. The results of the surveys of the fallout area have been represented conventionally as the land equivalent exposure rate readings at a 3 foot height at H+1 hour. In other words, the distribution of activity is measured by specifying the exposure rate that would be observed by a detector at a height of 3 feet above an infinite plane upon which the material has fallen and remained in place. This reading is extrapolated by a decay curve back to H+1 hour, even though, in all likelihood, the fallout material had not arrived at its surface location at this early time. In any case, such a plot is a representation of the surface density of active material, differing from a plot of curies per unit area by a factor which depends on the gamma ray energy spectrum.

Subject to the measurement of accurate decay curves for ~~fission-fusion~~ -

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~~fission-fusion~~ resulting from a fission-fusion-fission process fallout material, a $t^{-1.0}$ relationship has been assumed for exposure rate readings from land surface distribution of fallout. Such a decay curve represents the fission product $t^{-1.2}$ decay plus an increasing relative contribution from Np^{239}. It is therefore expected to be reasonably accurate for the first 4 to 6 days until the Np^{239} relative contribution again decreases and a greater negative exponent becomes appropriate.

Exposure rate readings in and above contaminated water are doubly sensitive to changes in the gamma energy spectrum through its influence on the effective source as well as on the spectrum at the measuring device. For this reason the decay exponent that was applied to the water readings was that measured in the decay tank aboard the M/V Horizon. For the Shot Zuni fallout this was measured to be ~~1.05~~ 1.13.

The data for the fallout radiation plot in Figure 3.7 have been secured from the following sources: **BEST AVAILABLE COPY**

(a) Project 2.65 helicopter-probe aerial survey: This survey directly measured the exposure rate at a position 3 feet above the ground of some of the atoll islands. The readings for successive days' surveys were extrapolated to H+1 hour and averaged.

(b) RadSafe surveys: The RadSafe aerial readings were reduced to 3 feet readings using calculated height conversion coefficients (see Appendix C) and an additional factor of 1.5. This factor has been found necessary to normalize the readings to those taken with the project 2.65 survey. The 2.65 instrument actually made measurements at 3 feet and had been well calibrated before and after use. The conversion factor is probably due to the geometry of the RadSafe detector unit in its

Figure 3.7 Zuni Fallout Radiation Plot. H+1 hour equivalent land exposure rates in r/hr. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

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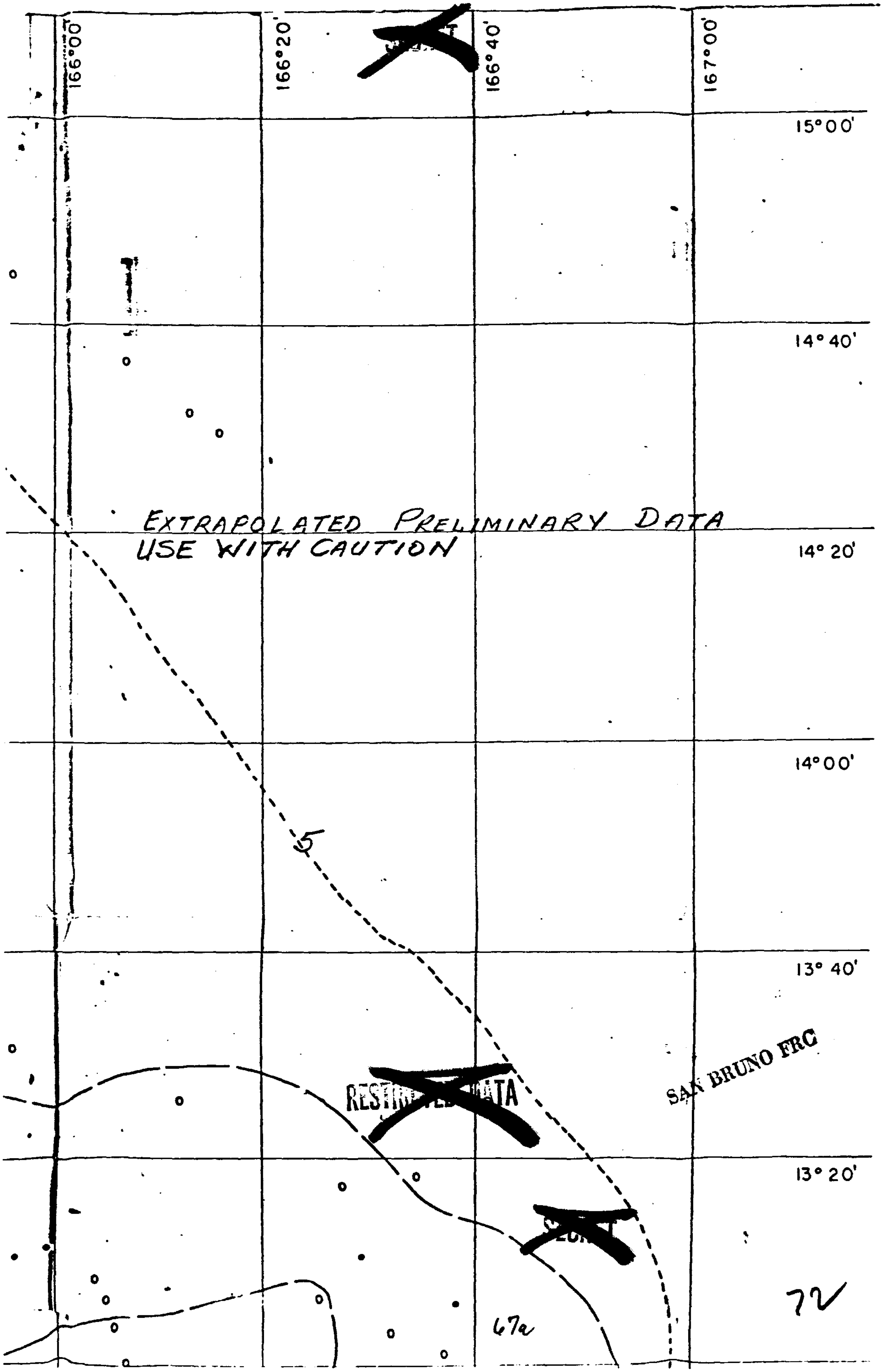
166°00'
166°20'
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15°00'
14°40'
14°20'
14°00'
13°40'
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EXTRAPOLATED PRELIMINARY DATA
USE WITH CAUTION
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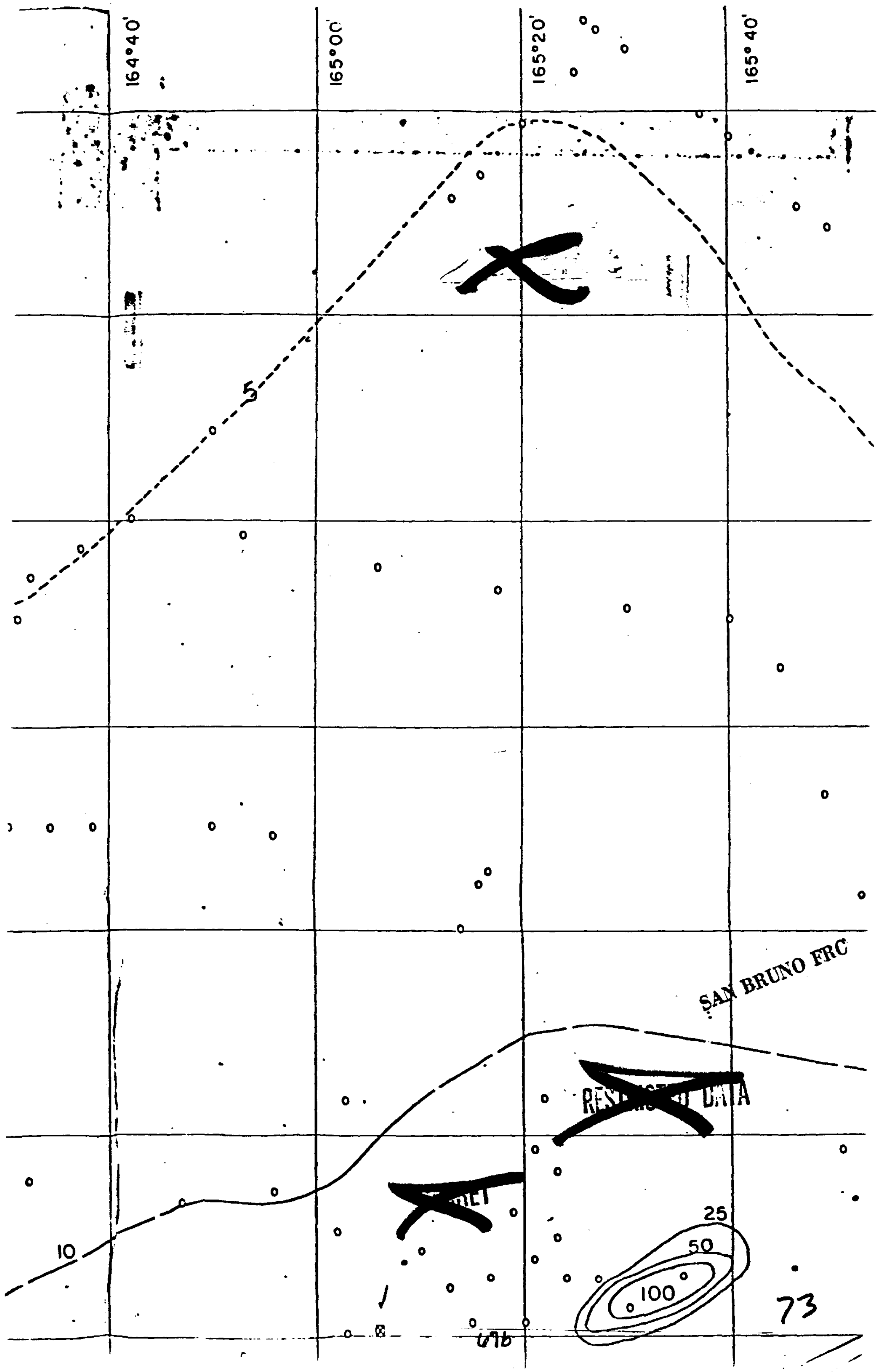
164°40'
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50
100
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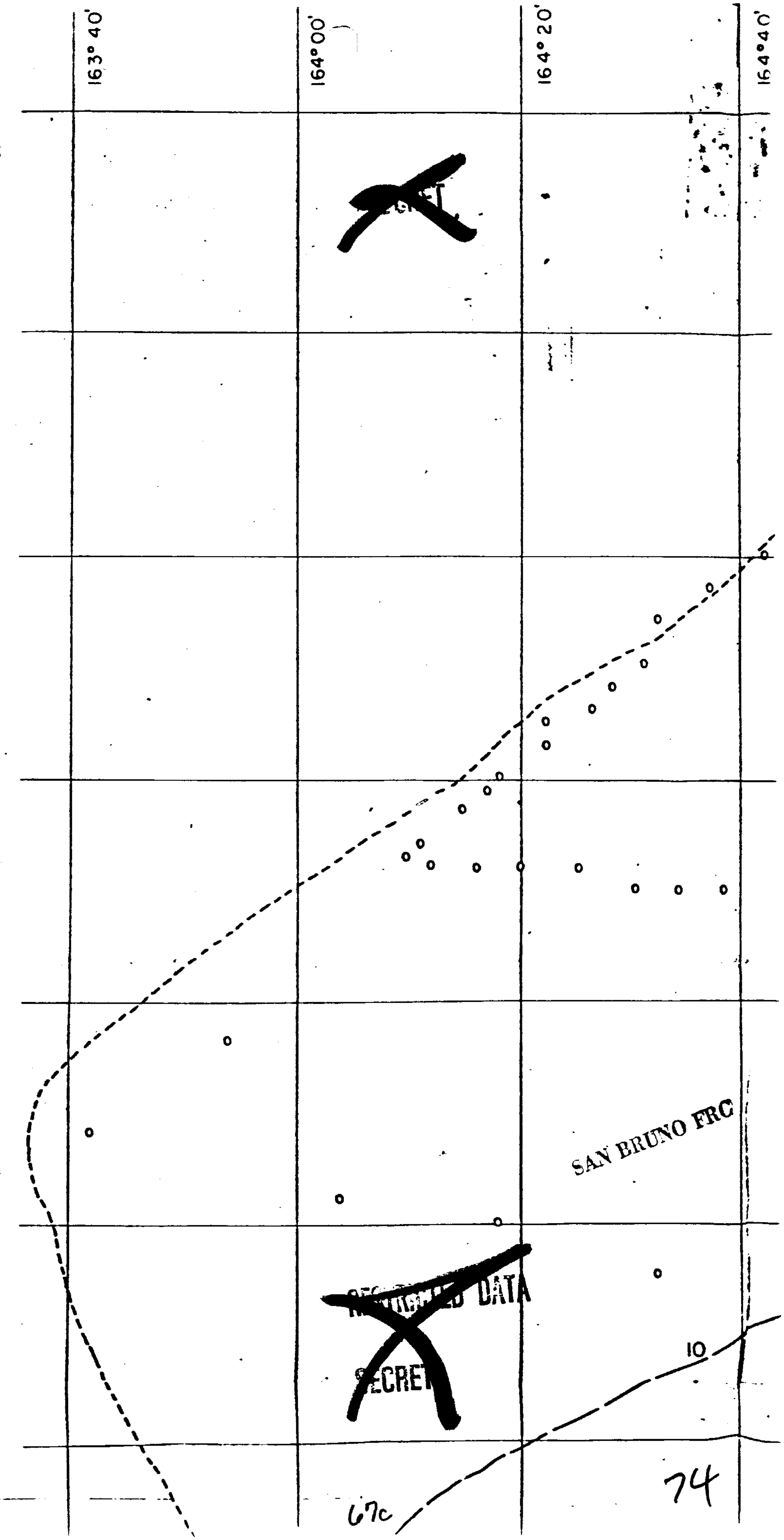
73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164° 40'
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10
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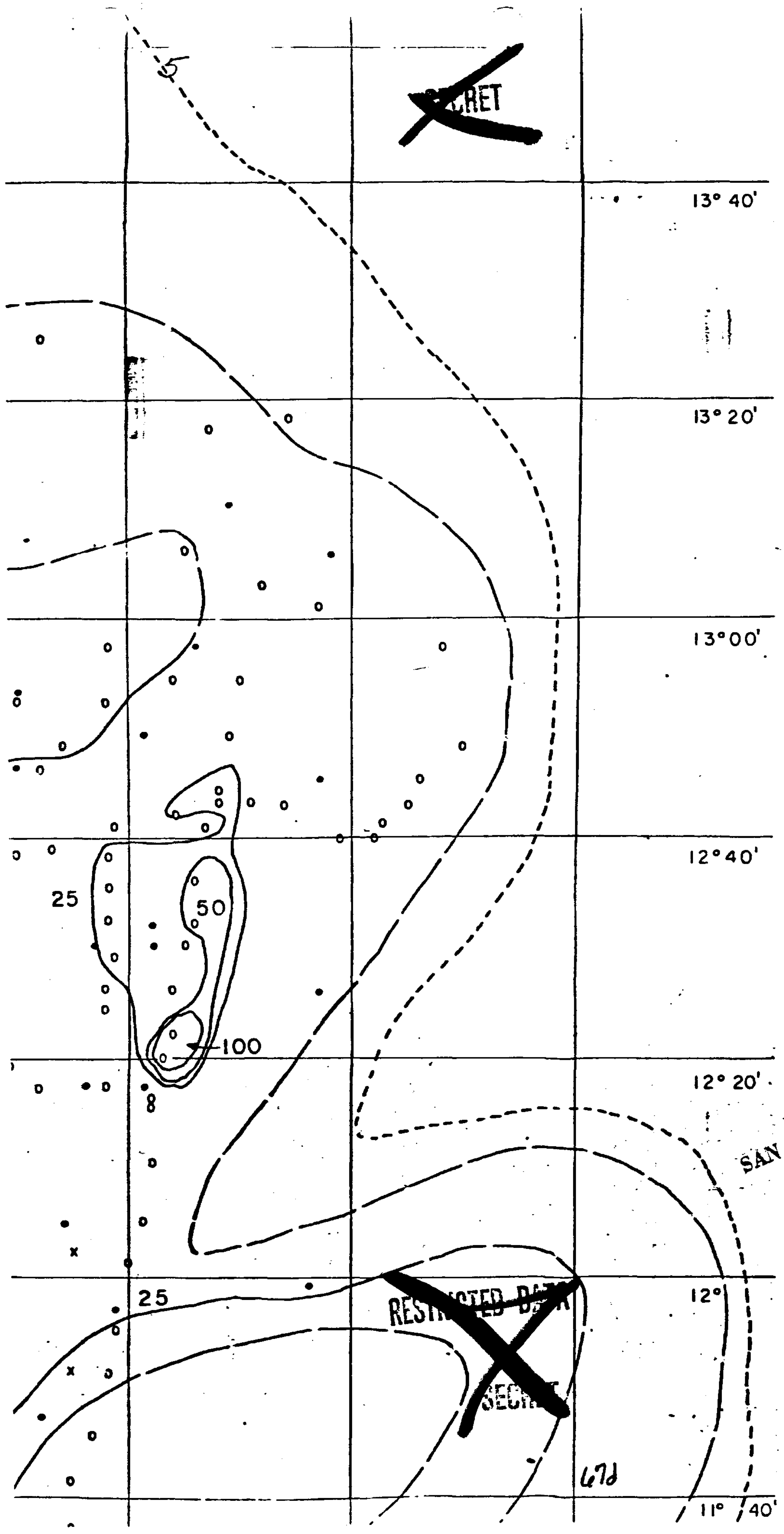

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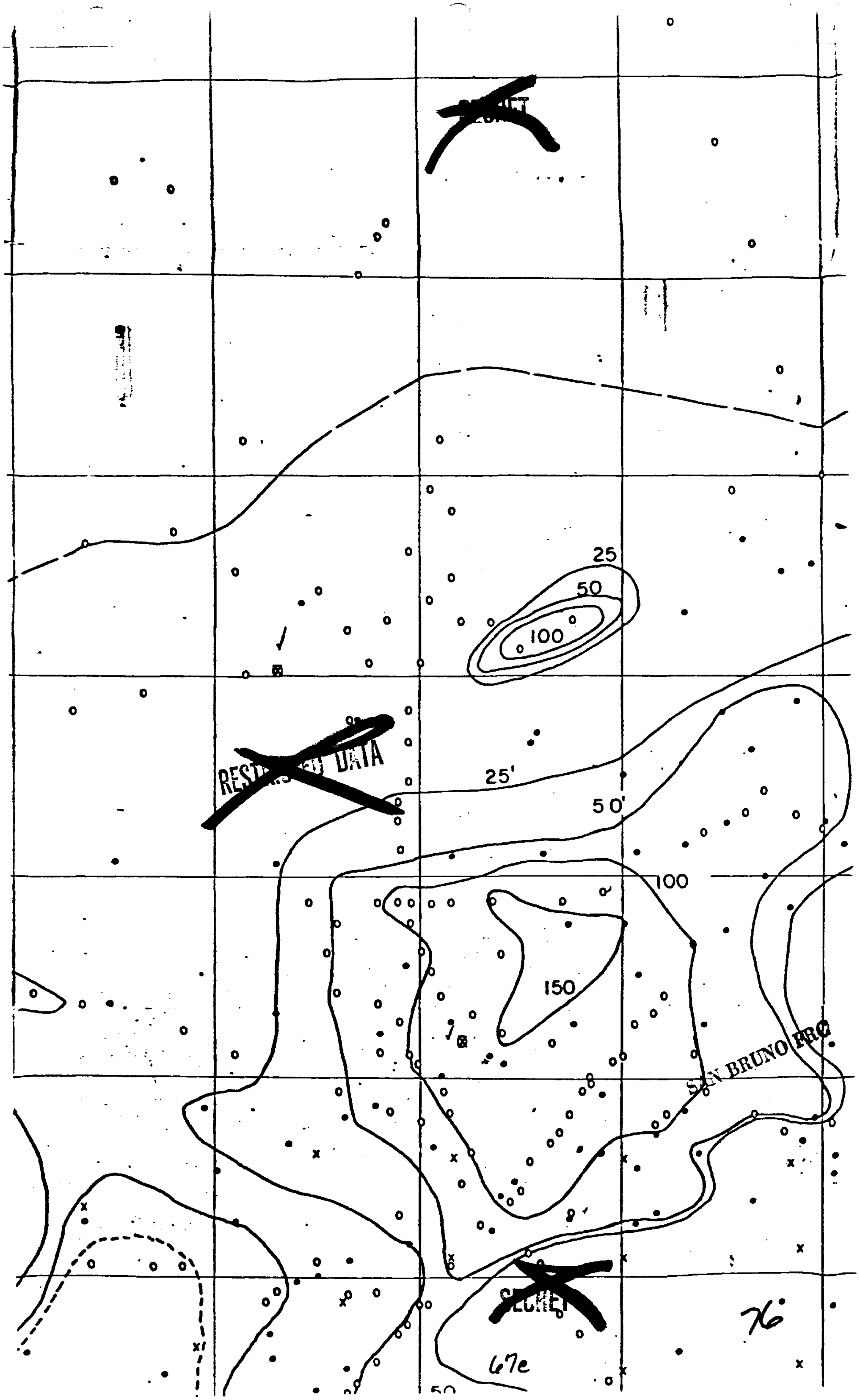
25
50
100
25'
50'
100
150
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76
67e
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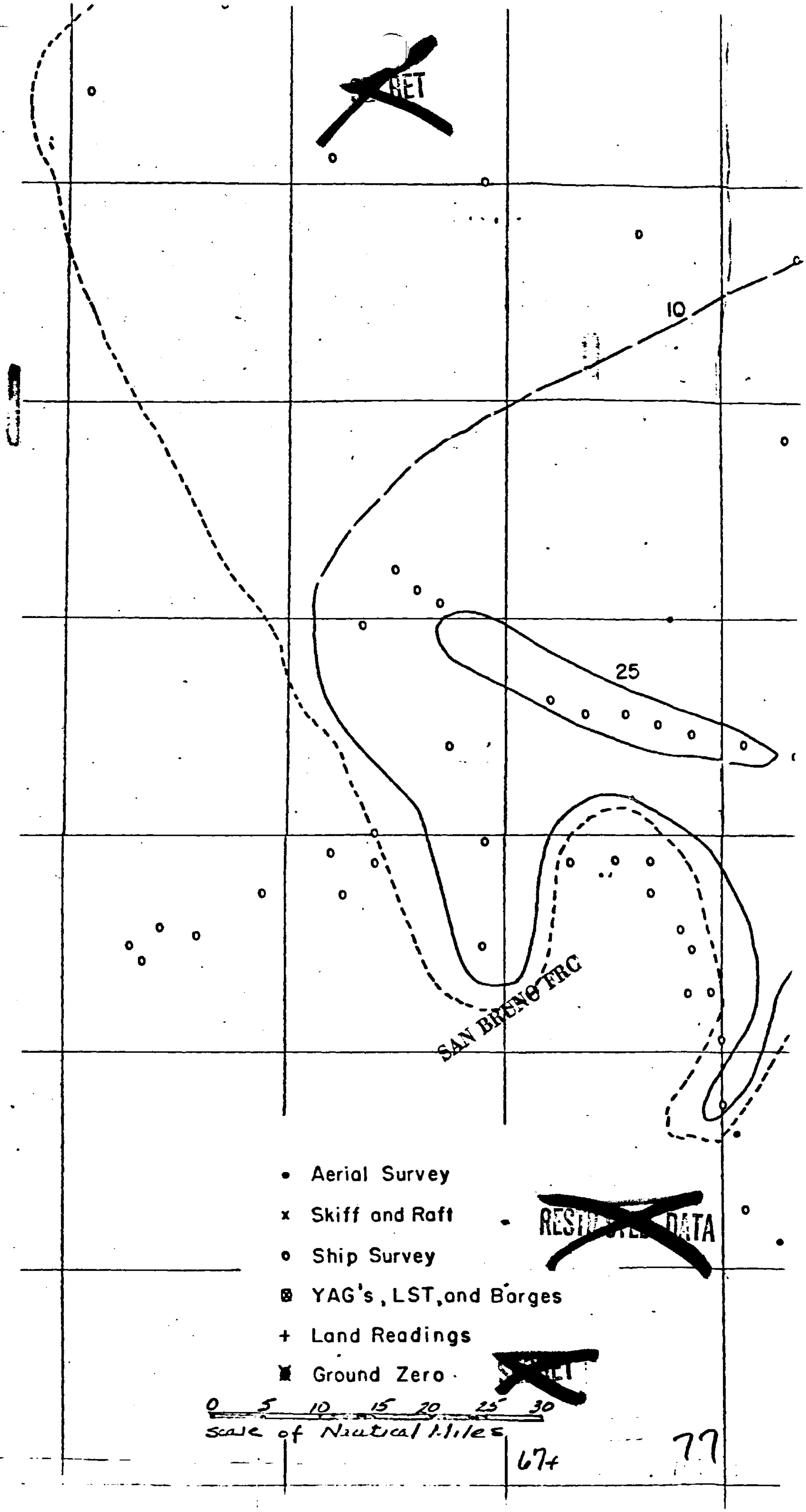

10
25
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Aerial Survey
Skiff and Raft
Ship Survey
YAG's, LST, and Barges
Land Readings
Ground Zero
0 5 10 15 20 25 30
Scale of Nautical Miles

attachment to the helicopter. Other readings on islands were also available from recovery party monitors.

(c) The Project 2.63 standard geometry monitor readings on the bottles collecting the total fallout on the pontoon raft, skiff, and island stations were used to determine the relative ground readings at these locations. The readings were normalized to the infinite land exposure rate by using the measured 3 feet exposure rate at Sites George and William together with the bottle monitor reading from the station there. This procedure is subject to some errors due to the possible variation in the collection efficiency with position in the fallout zone. For example, the funnel type collectors are more likely to retain large particulate than a fine aerosol and hence are likely to be more efficient at the stations nearer the shot point.

(d) The YAG 39 and YAG 40 "time-intensity recorder" on the forward deck provided exposure rate readings which approximate the land equivalent reading, although they were affected by the efficiency of the deck as a collecting surface. In general, these readings were found to be low compared to measurements in the ocean water and monitor readings of total collector samples.

(e) The ~~standard geometry~~ monitor readings taken under conditions of standard geometry of the Project 2.63 open-close collector trays and the total collector trays also furnished relative readings at the following locations: North Site How, YFNB barges, YAG 39, YAG 40, and the LST 611. These readings were normalized using the reading of the ocean water at the YAG 40 position. Again these readings are subject to error from a varying fallout collection efficiency.

(f) The Two YAG's, the Project 2.62 DE's, and the M/V Horizon performed measurements of exposure rate as a function of depth in the water. These readings give a direct estimate of the total activity present in a vertical column of water and hence of the equivalent land rate. These exposure rate versus depth profiles were also intended to provide an average depth of mixing so that the more numerous surface readings could also be used to compute land equivalent exposure rates. However, since the Zuni shot was detonated on land, much of the activity was associated with sizeable solid particles and only part of the activity remained in the upper few hundred meters accessible to the probe. Thus, these readings are subject to relatively large errors. BEST AVAILABLE COPY

(g) The numerous surface exposure rate readings measured by the survey vessels and the YAG's can be reduced to equivalent land radiation readings if the effective depth of mixing of the radioactive water is known. The preliminary reduction of the radiation depth profile data indicated that the depth of penetration was about 54 meters at H/10 hours, increased linearly to 90 meters at H/30 hours, and remained constant after this time. The data from the surface readings were therefore reduced using these depths of penetration at all positions in the fallout pattern. Neglecting space variations in the depth of penetration can produce some errors, particularly close in, because the larger sized particulate in the fallout which arrives nearer to the shot point is likely to penetrate more rapidly under the influence of gravity than would be expected from the water mixing rate. Therefore, the effective depth of mixing could easily be much greater near ground zero than in the more remote regions of the fallout pattern where smaller particulate is responsible for the activity.

In order to calculate Σ,

~~The~~ factor ~~used~~ to reduce the reading under the surface of the water
it is necessary to assume that the activity in the water is laid [illegible]

to the equivalent land rate ~~was~~, 10 X d, where d is the depth of mixing.
→ the resultant factor is ——

This factor can be derived as follows: the activity present in a vertical column of 1 m² crosssection and volume "d" m³

of water is to be placed on one m² of ~~surface~~ the plane, and a density of 1 curie/m³

in water produces one tenth of the exposure rate ~~as~~ existing at 3 ft. above a surface distribution

of 1 curie/m². (See Appendix C.)

A rough correction was made in the survey data for the motion of the ocean water subsequent to the deposition of the fallout. For the purposes of this preliminary report the currents were approximated by a uniform drift of 10 nautical miles per day toward 260 degrees azimuth in the region north of 12 degrees 00 minutes north latitude, a drift of 10 miles per day toward 180 degrees azimuth in the region southwest of Bikini Atoll, and a zero drift southeast of Bikini Atoll. These motion patterns were smoothly connected in intermediate regions. The motion was assumed to commence at an average time ~~of arrival~~ of H/6 hours.

(h) The Project 2.64 aerial survey readings taken at an altitude of about 300 feet were reduced to readings in the water by multiplication by a factor of 10. This factor included a factor of 3.3 for the finite acceptance angle of the detector, 1.5 for the effective air attenuation between the water surface and 300 feet, and 2 to convert the reading over the water into a reading inside the water (see Appendix C). Using the same normalization factor computed for the Project 2.62 water readings, these numbers were reduced to equivalent land exposure rates.

3.1.1.6 Central Time of Arrival Contours. The contours in Figure 3.8 represent the calculated times at which a particle originating directly

is placed on a plane and the exposure rate measured 3 ft above the plane.

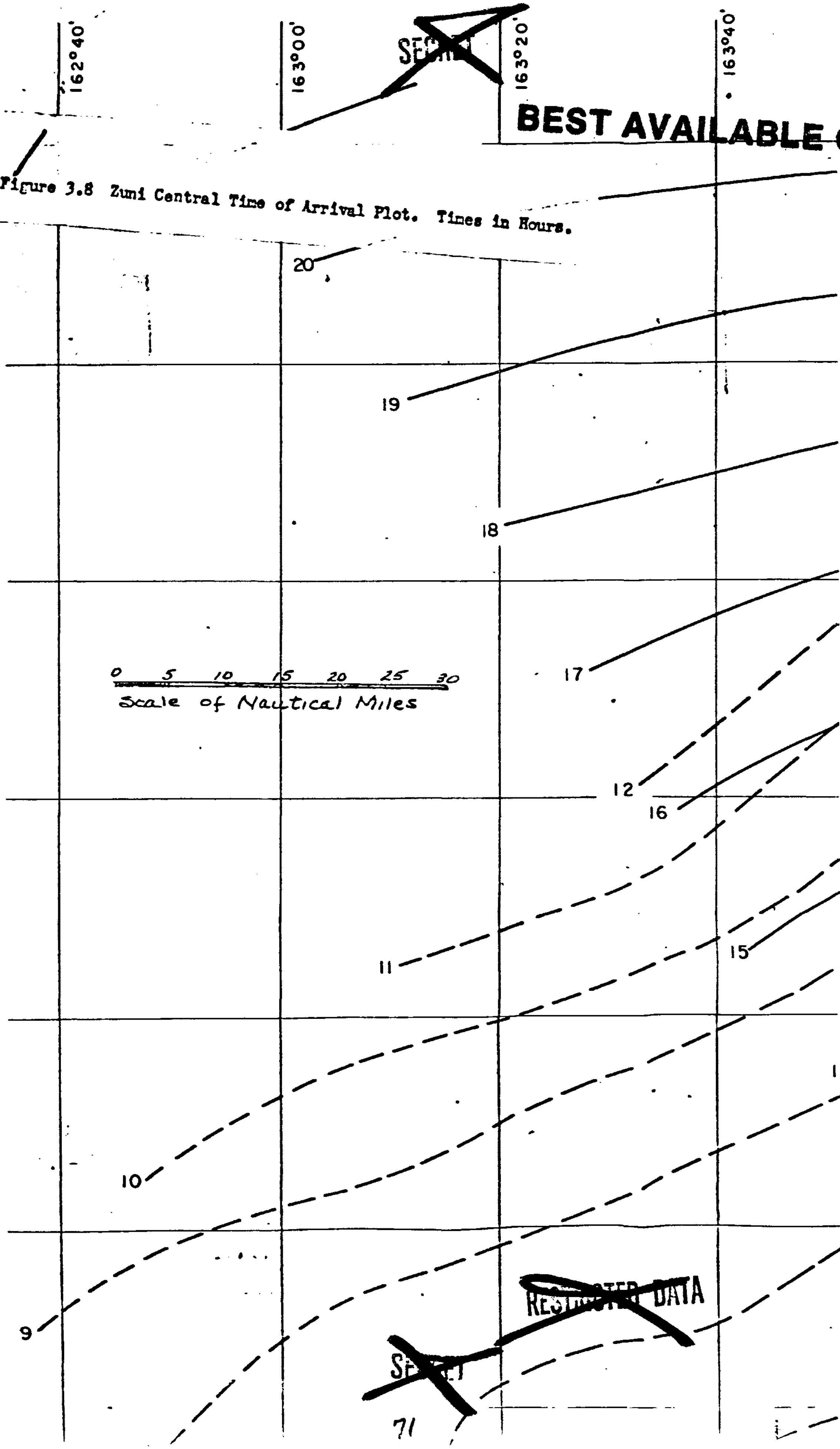
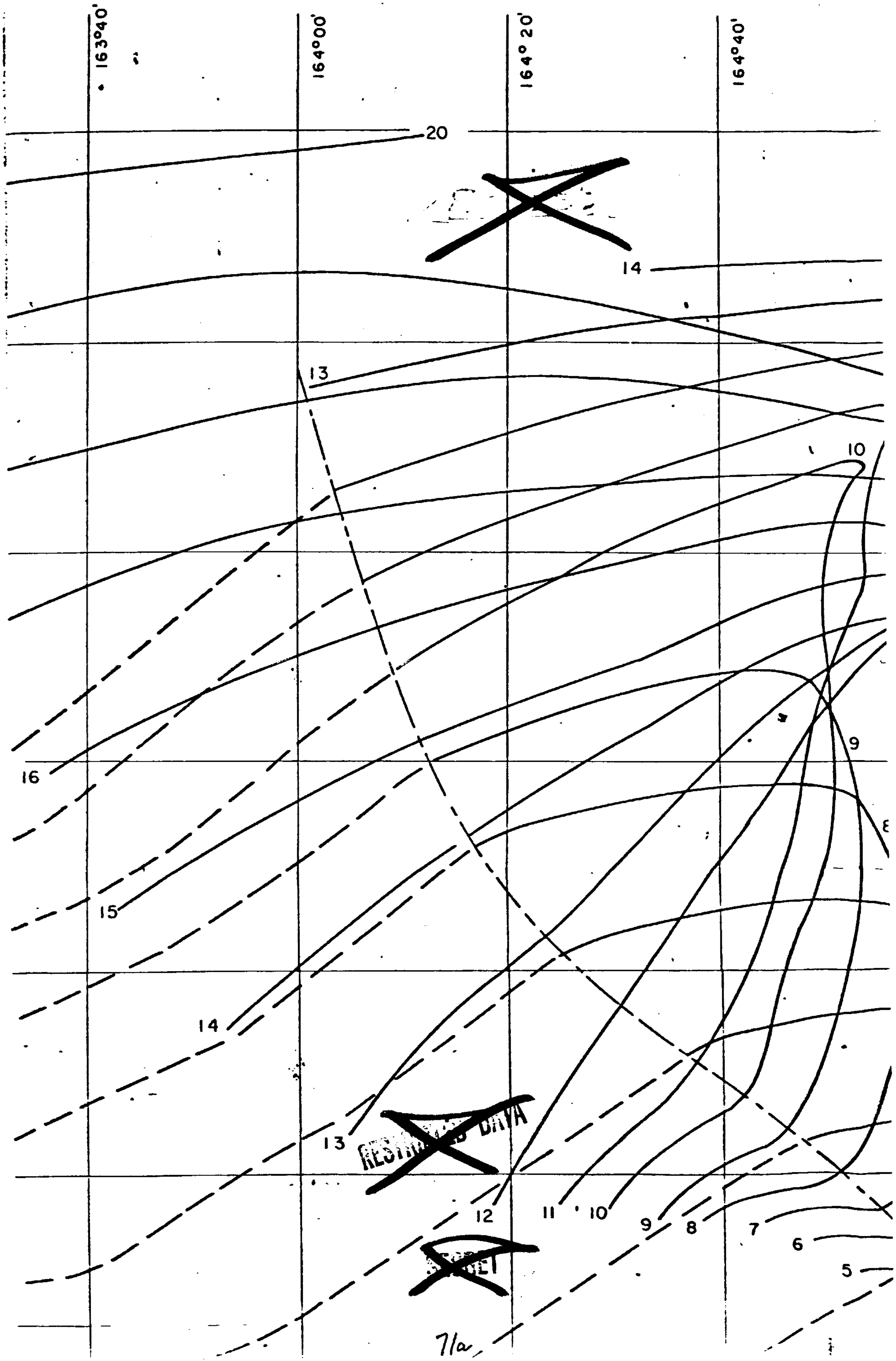


Figure 3.8 Zuni Central Time of Arrival Plot. Times in Hours.



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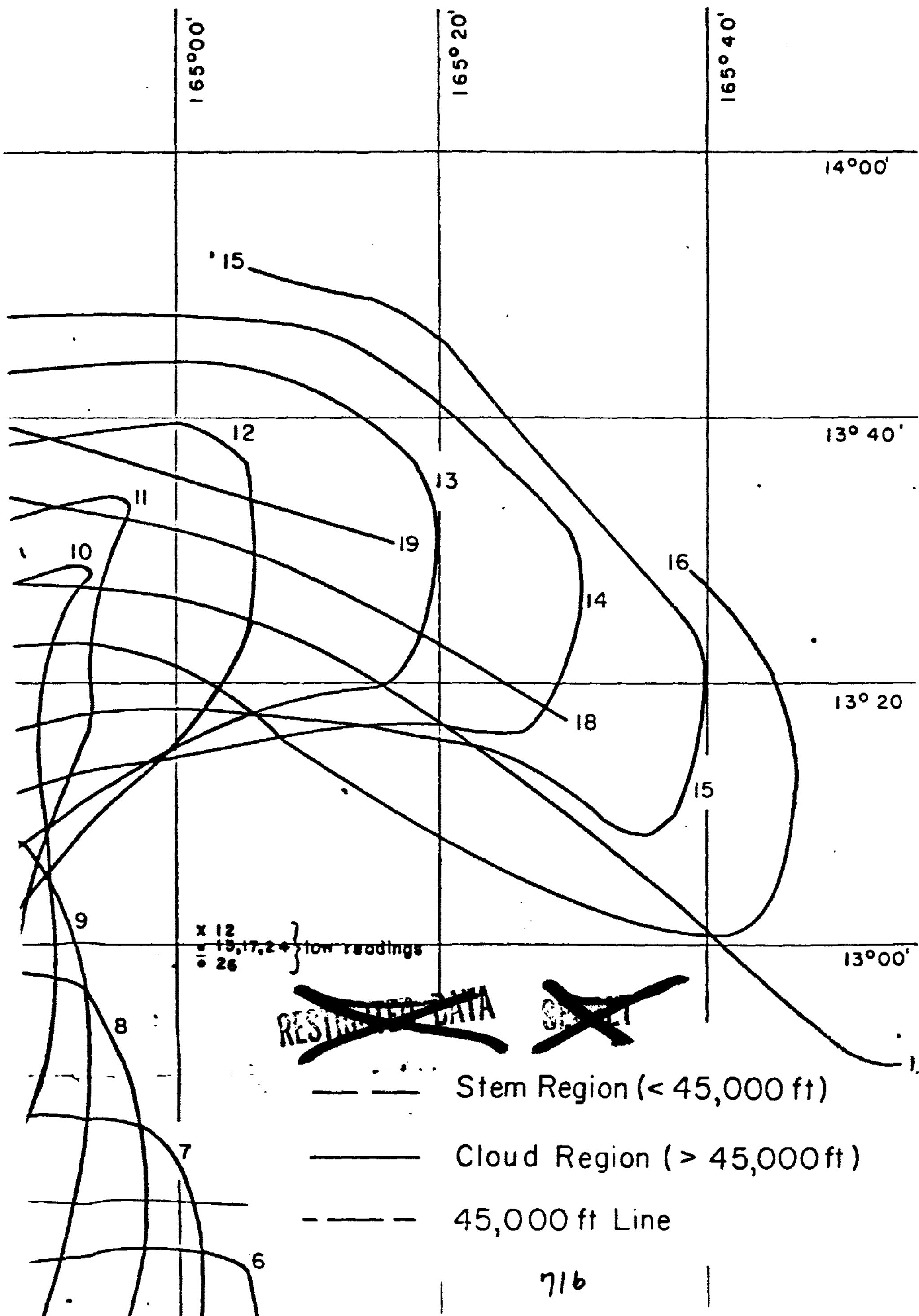

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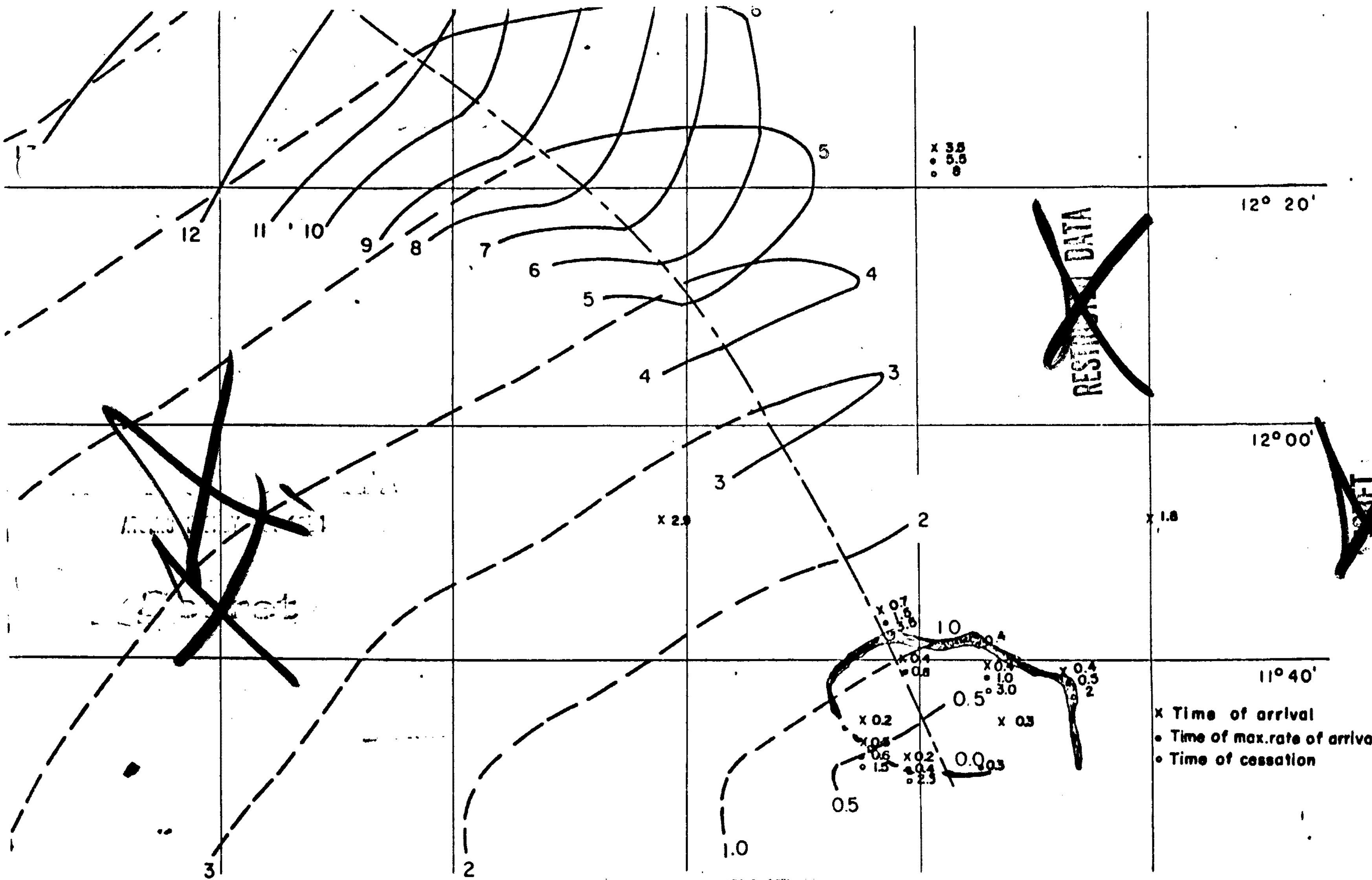
12° 20'
12° 00'
11° 40'
x Time of arrival
• Time of max.rate of arrival
∘ Time of cessation
12
11
10
9
8
7
6
5
4
3
2
1.0
0.5
0.0
x 3.5
• 5.5
∘ 8
x 2.9
x 1.8
x 0.7
• 1.6
∘ 3.5
x 0.4
• 0.8
x 0.4
• 1.0
∘ 3.0
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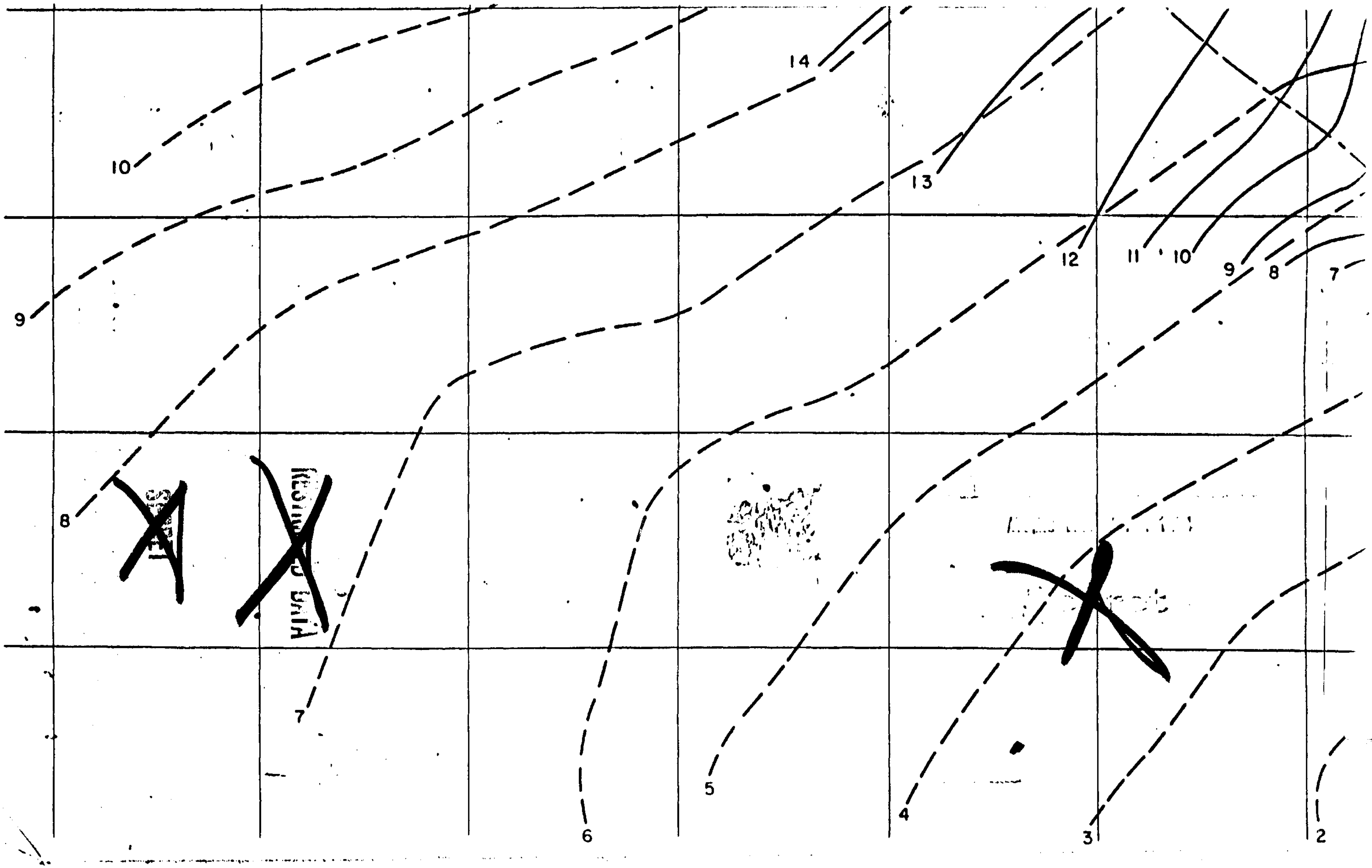
x 0.2
• 0.4
∘ 2.3
0.3

7/c



85

above surface zero would arrive at a location on the surface. The fact that contours are exhibited which indicate two fallout times associated with some points results from the possibility that particles from two regions in the initial cloud can arrive at the point. Since the initial cloud is not a vertical line source but has appreciable horizontal extent, the actual time of arrival at a point corresponds to the minimum central time of arrival ~~for all points within a cloud radius~~ associated with all locations encompassed by a circle of cloud radius drawn about that point. Likewise, the time of cessation corresponds to the maximum central time of arrival for all locations ~~points~~ within that circle ~~a cloud radius~~.

Figure 3.8 also presents the observed time of arrival, time of peak rate of arrival of activity, and time of cessation of fallout observed for the Zuni event. The data is gathered from the following sources:

(a) Time of arrival detectors on the skiffs and pontoon rafts.

(b) Gamma "time-intensity recorders" aboard YAG 39, YAG 40, LST 611, YFNB 13, YFNB 29, and the Site How station of Project 2.63.

(c) Monitor of trays of incremental samplers located aboard ships by Project 2.63 and on islands by Project 2.65.

~~(d) The gamma exposure rate recorders installed at some land stations by Project 2.2.~~

3.1.1.7 Ten Hour Exposure Contours. For applications to practical military situations, the H+1 hour land equivalent exposure rate is not particularly appropriate. The times of arrival of the fallout may vary greatly along a particular radiation contour and hence the total dosage to personnel in those areas will vary. Figure 3.9 presents contours of the total exposure received at locations in the fallout zone from the

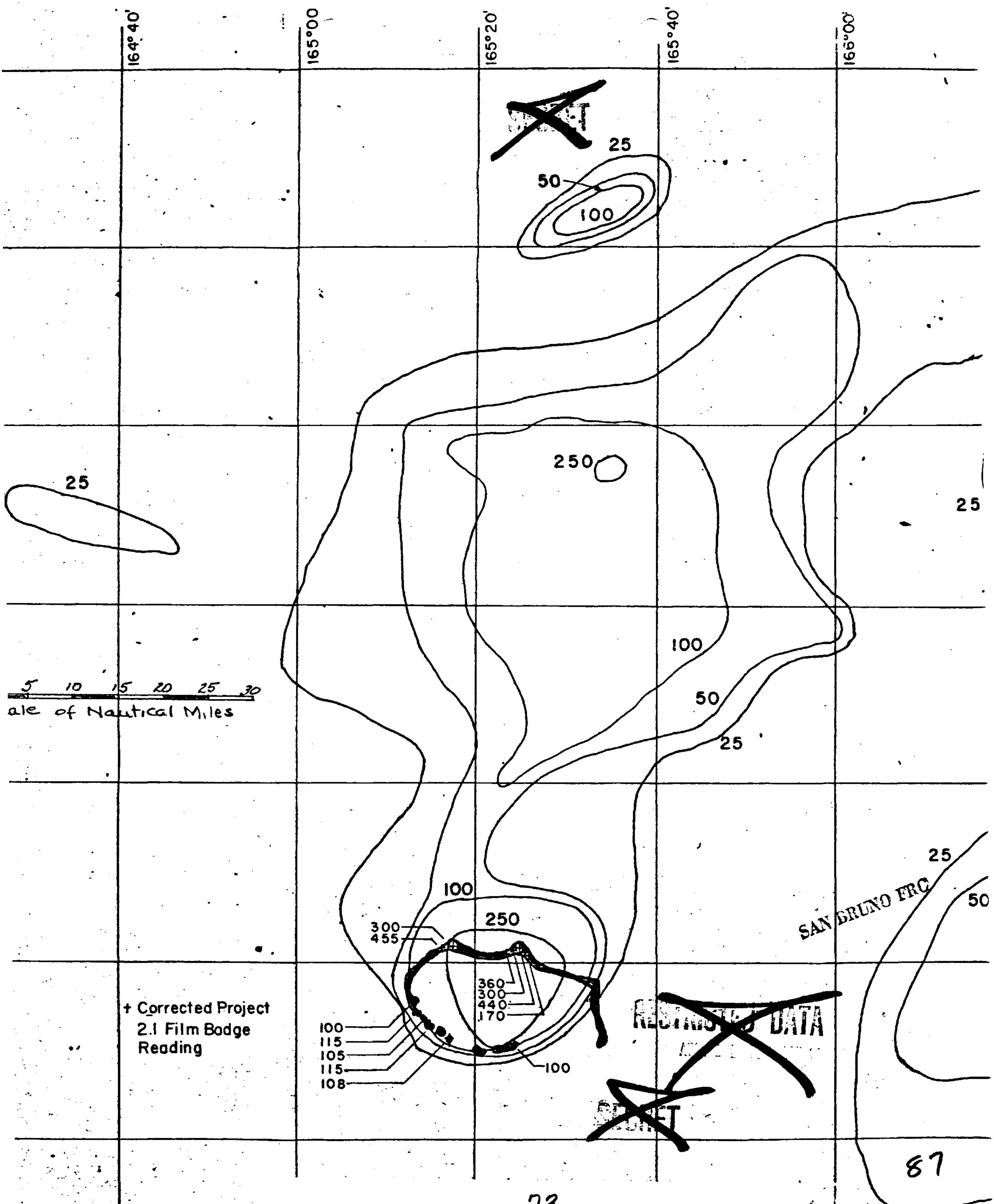


Figure 3.9 Zuni Ten Hour Exposure Contours. Exposure in r.
EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION

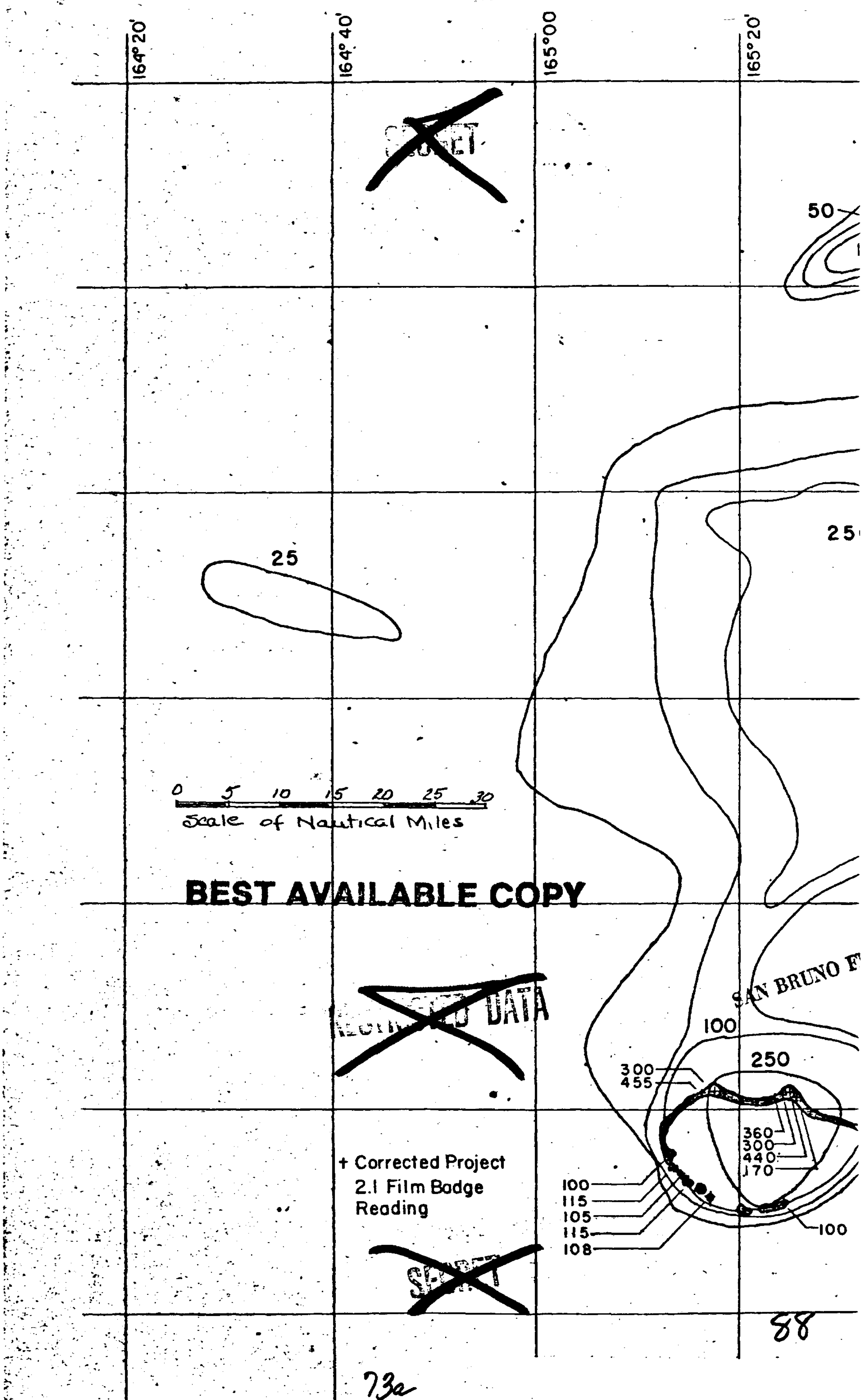
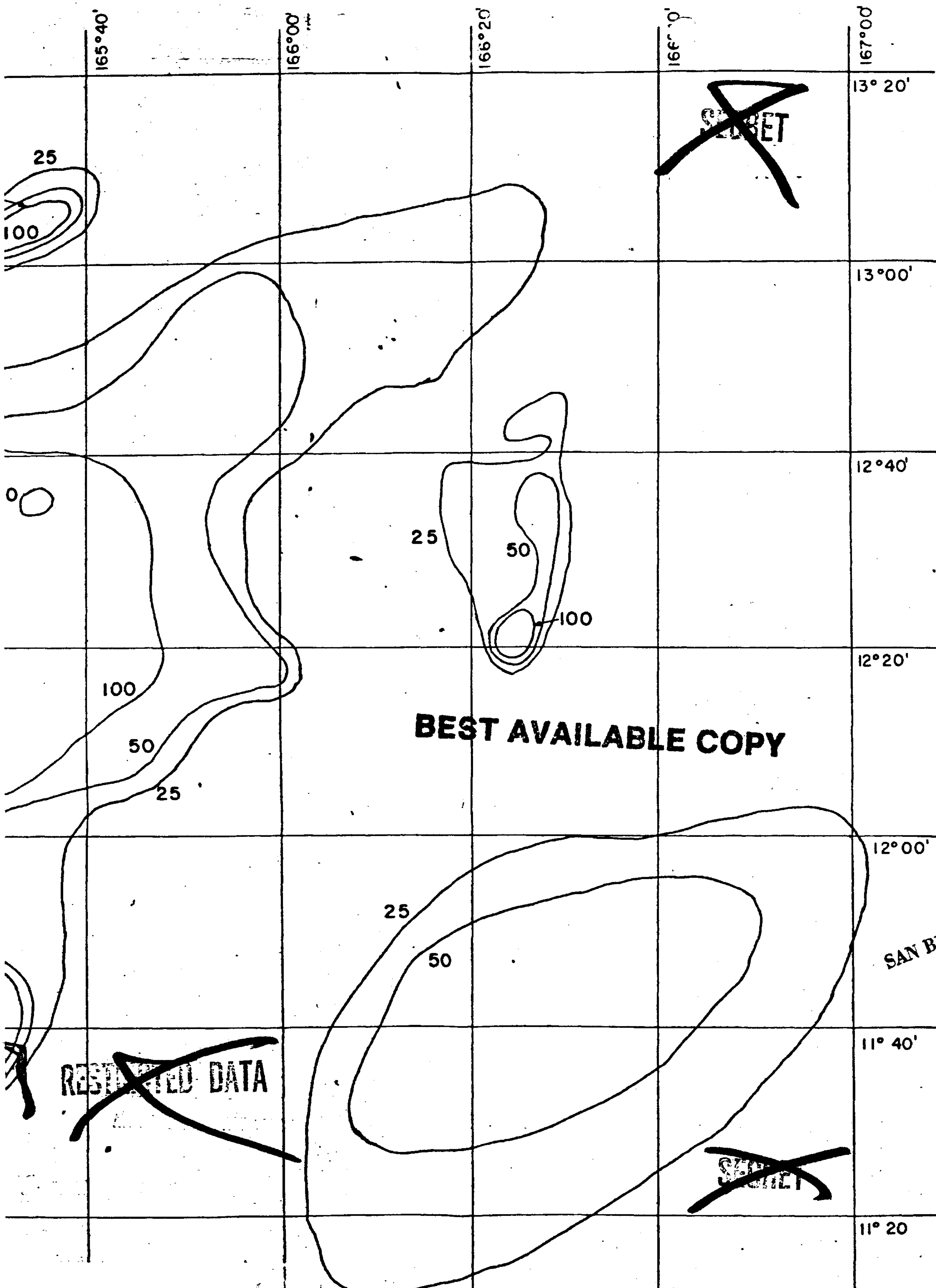


Figure 3.9 Zuni Ten Hour Exposur
EXTRAPOLATED PRELIMINARY



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Contours. Exposure in r.
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central time of arrival of fallout until 10 hours later. The figure has been constructed using the experimental fallout radiation distribution from Figure 3.7 and the calculated central time of arrival contours of Figure 3.8. The assumption has been made that the activity decays according to a $t^{-1.0}$ decay relationship. In interpreting this plot in terms of exposure to personnel experiencing the fallout the assumption is made that the exposure is the same as that which would have been experienced if all the material had arrived at the central time of arrival of fallout. This assumption is equivalent to an assumption of equal areas demonstrated in Figure 3.10. **BEST AVAILABLE COPY**

The total exposure data of the Project 2.1 film badges and dosimeters were corrected for the difference between recovery time and 10 hours after the central time of arrival and have been presented as data points on Figure 3.9.

3.1.1.8 Gross Decay ~~Curves~~ Exponent. The decay characteristics of the fallout samples will be, in general, determined by the combination of the fission product and neutron activation product decays. The predominant capture product activity at the times the samples were observed was from Np^{239} (2.3 day half life) which occurs in abundance whenever the fission yield of the weapon results mostly from fast neutron fission of U^{238}. The assumption of a $t^{-1.0}$ decay for analysis of the Zuni fallout radiation data was chosen to represent the combination of the fission product and Np^{239} activity during the period of the surveys (D to D+4). Later, more precise analyses will undoubtedly be based on the actual observed decay.

FIG. 8

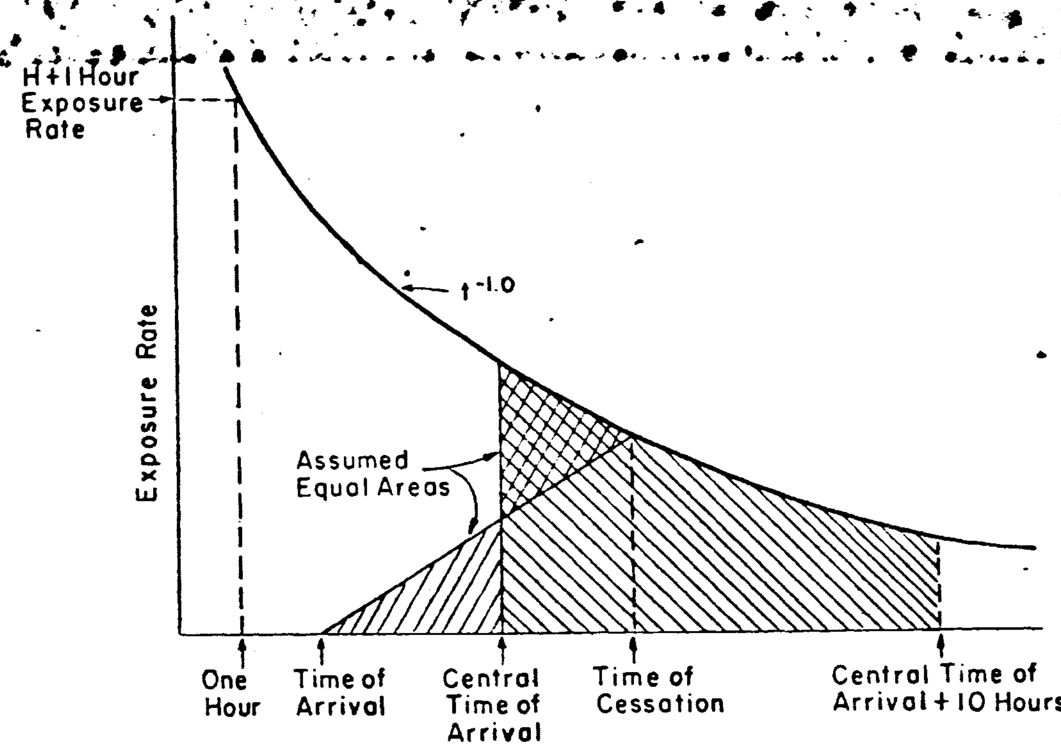

Figure 3.10 Calculation of Ten Hour Exposure Values. Ten hour exposure as used in this report is area under curve from central time of arrival to central time of arrival plus 10 hours.

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The Np^{239} capture to fission ratio reported by UCRL for the Zuni event was approximately 0.36.

Preliminary observations by Projects 2.63 and 2.65 on the gamma photon decay, gamma exposure rate decay, beta disintegrations per minute decay, and the gamma exposure rate decay observed by measurements on radiation fields from contaminated islands are summarized in Table 3.2. The preliminary results from Projects 2.62 on the decay constant applicable to the gamma exposure rate measured in contaminated water has also been included in Table 3.2.

TABLE 3.2 GROSS DECAY EXPONENTS FOR ZUNI

$$A(t_2) = A(t_1)\left(\frac{t2}{t_1}\right)^{-n}$$

	Time Range (hours)	5-20	20-50	50-200
Decay Exponent	Gamma Photons*	0.6	0.6	1.2
	Gamma Exposure Rate	0.9	0.9	1.0
	Beta dis/min#	0.6-0.9	0.7-1.4	0.8-1.0
	Field Gamma Exposure rate	-	0.9	-
	Gamma Exposure in Water	-	1.13 ~~1.05~~	-

*YAG 40 Samples only.

#Samples subject to much variation. Numbers quoted are ranges of observed decay exponents.

3.1.2 LaCrosse.

3.1.2.1 Introduction. The LaCrosse Shot was fired on an artificial island on the reef off Site Yvonne, Eniwetok Atoll, on 5 May 1956, at 0625M. The yield of the weapon was measured to be 38.5 KT. The environment of the shot point consisted of shallow water and reef. Therefore, the burst was essentially of the land surface type. In the vicinity of the burst point was located large quantities of iron pipe used in the diagnostic instrumentation.

3.1.2.2 Particle Fall Plot. The particle fall plot illustrated in Figure 3.11 has been constructed for only the larger particle sizes, since only the atoll area fallout was documented, and hence does not need to include space or time variation of the wind structure. The other comments made in Section 3.1.1.3 about the limitations and interpretation of this plot are applicable here also.

3.1.2.3 Characterization of Fallout Material. Project 2.65 only participated on a limited basis in the fallout collection from the LaCrosse Shot. The best sample was secured from a truck canvas on Site Cone. Two types of particles were observed, one of which appeared to resemble natural white coral and the other which was partially or totally black and contained varying amounts of iron. The radioactivity appeared to be uniformly distributed throughout the volume of both types of particles. Eighty-seven percent of the activity was associated with particles in the 210-420 micron sieved size fraction (cf Figure 3.11). Project 2.65 observed indications of fractionation of Np^{239} relative to Mo^{99}. The Mo^{99} activity was assumed to measure the fission product activity and

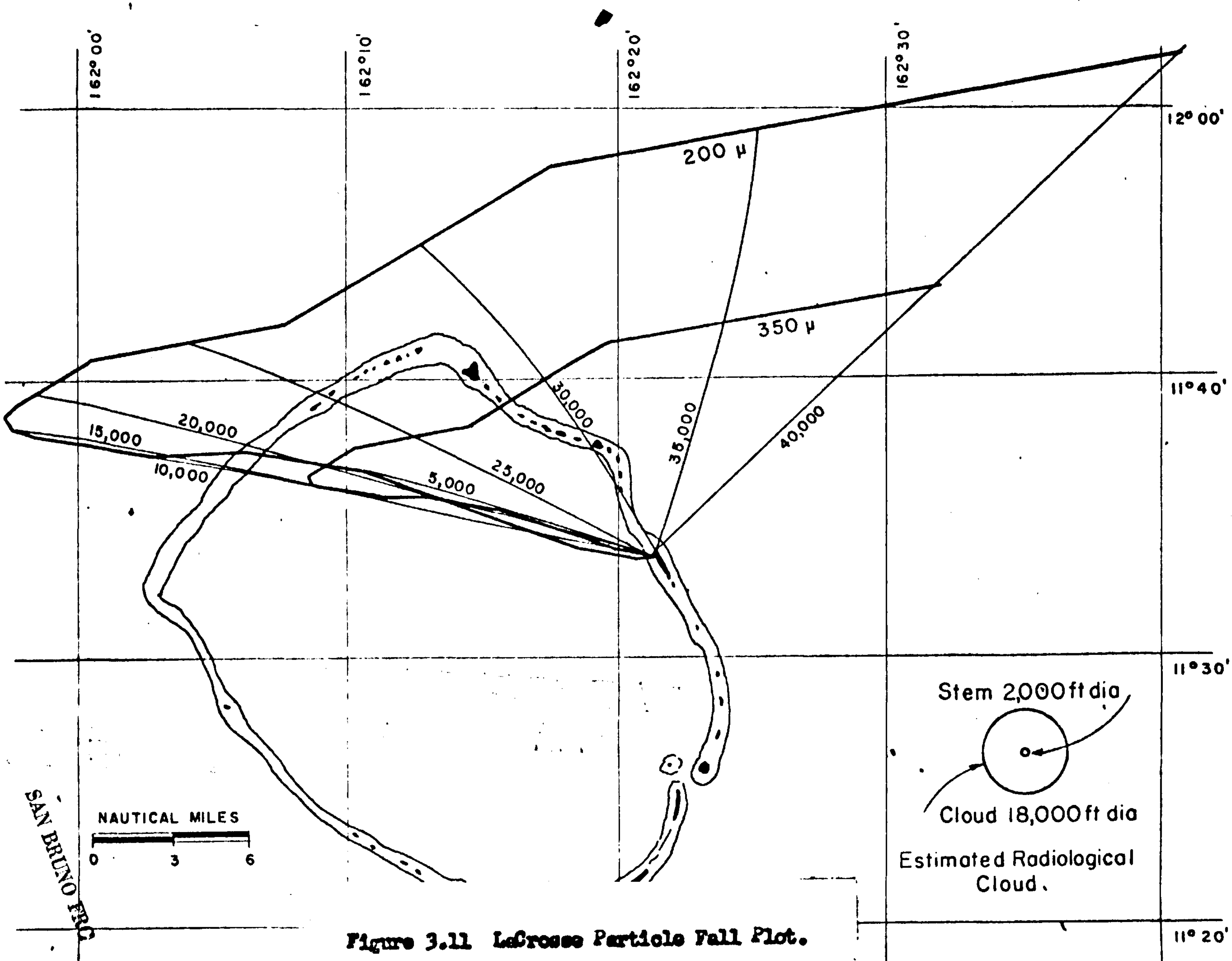

Figure 3.11 LaCrosse Particle Fall Plot.

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a capture to fission ratio was calculated for each sample. The apparent ratio seemed to vary from sample to sample with possibly a decrease with increasing particle size, varying from approximately 0.28 in the smallest sizes (75 micron) to 0.20 in the largest (200 micron). These numbers are appreciably larger than those from the cloud sample analysis performed by LASL which yielded a capture to fission ratio of 0.086. Therefore, there was apparently an over abundance of Np^{239} in these samples as compared with the Mo^{99}.

3.1.2.4 Land Equivalent Distribution of Fallout. Radiation data at sites on the islands were available from two sources: The Project 2.65 helicopter-probe survey and RadSafe readings. The probe readings have been corrected to H+1 hour by using a $t^{-1.2}$ decay expression. In addition to this factor, the RadSafe readings were converted from readings at 25 feet and 50 feet altitudes to 3 feet readings by multiplying by 2.5 and 3.2 respectively. Where many readings were taken over the same island, the D-day RadSafe reading and the three successive day probe readings were averaged. In these cases the consistency of the readings was within a factor of two. The resulting radiation pattern is characterized by the data points in Figure 3.12. Unfortunately, the data do not cover enough area to allow contours to be drawn, so only a few general conclusions will be derived from this event. The radiation levels near the crater are indicated in Figure 3.13.

3.1.2.5 Central Time of Arrival Contours. Figure 3.14 presents the predicted central time of arrival contours for the LaCrosse Shot. No time of arrival detectors were operating during the fallout from this

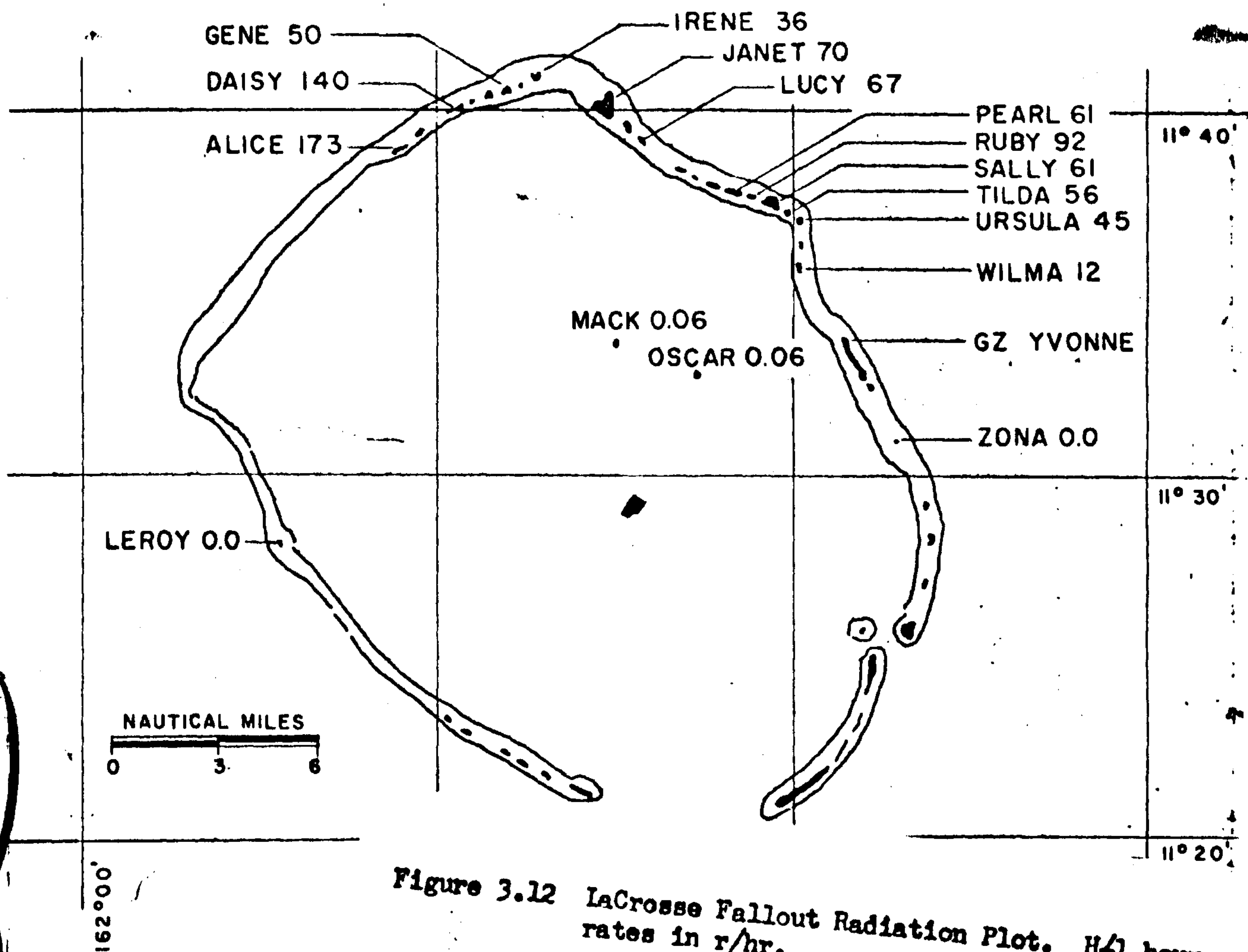

Figure 3.12 LaCrosse Fallout Radiation Plot. H+1 hour equivalent land exposure rates in r/hr.

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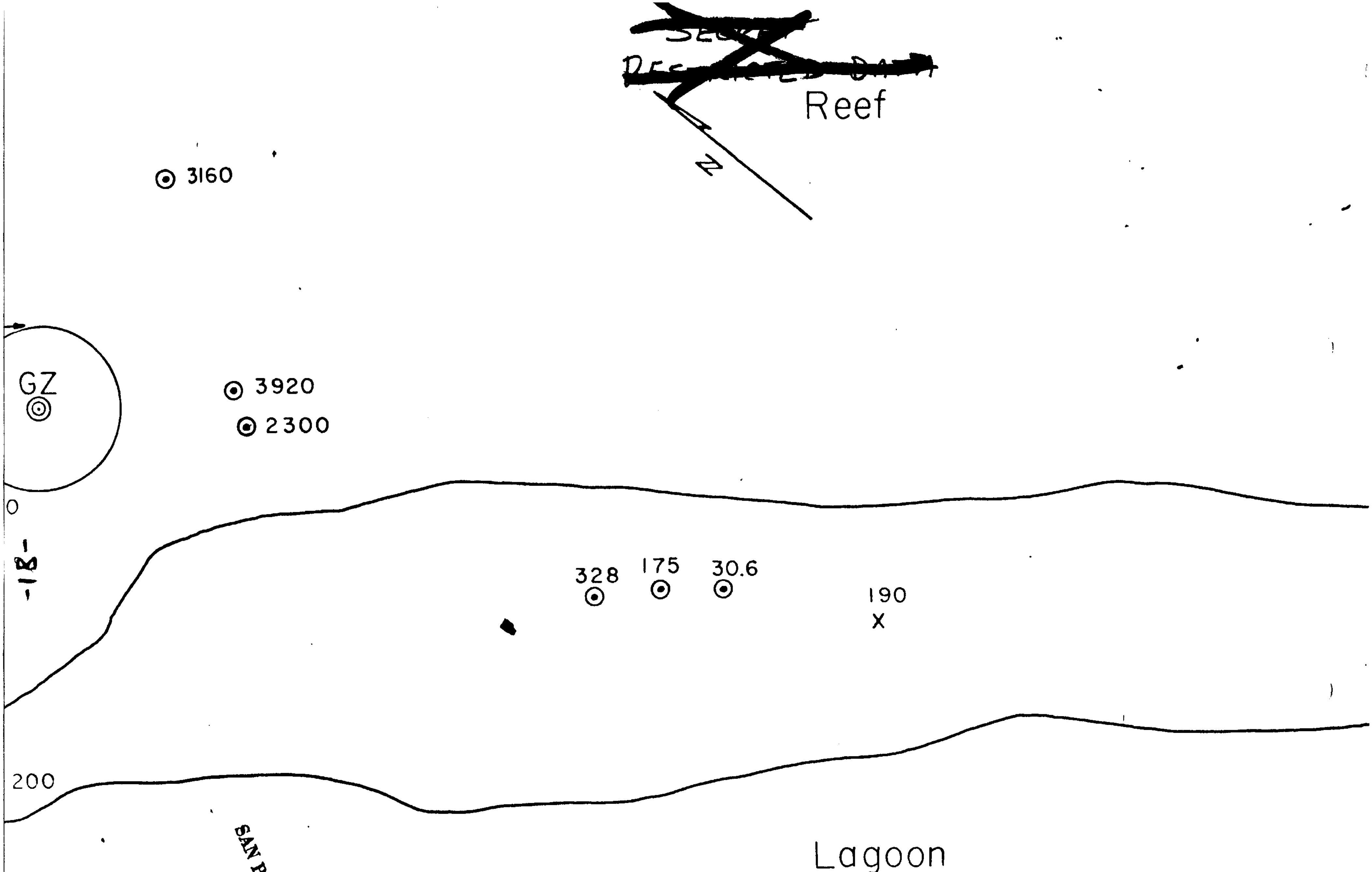

Figure 3.13 LaCrosse Exposure Rates Near Crater. Equivalent land readings on the reef and on Yvonne converted to r/hr at H+1.

[redacted]

[redacted]

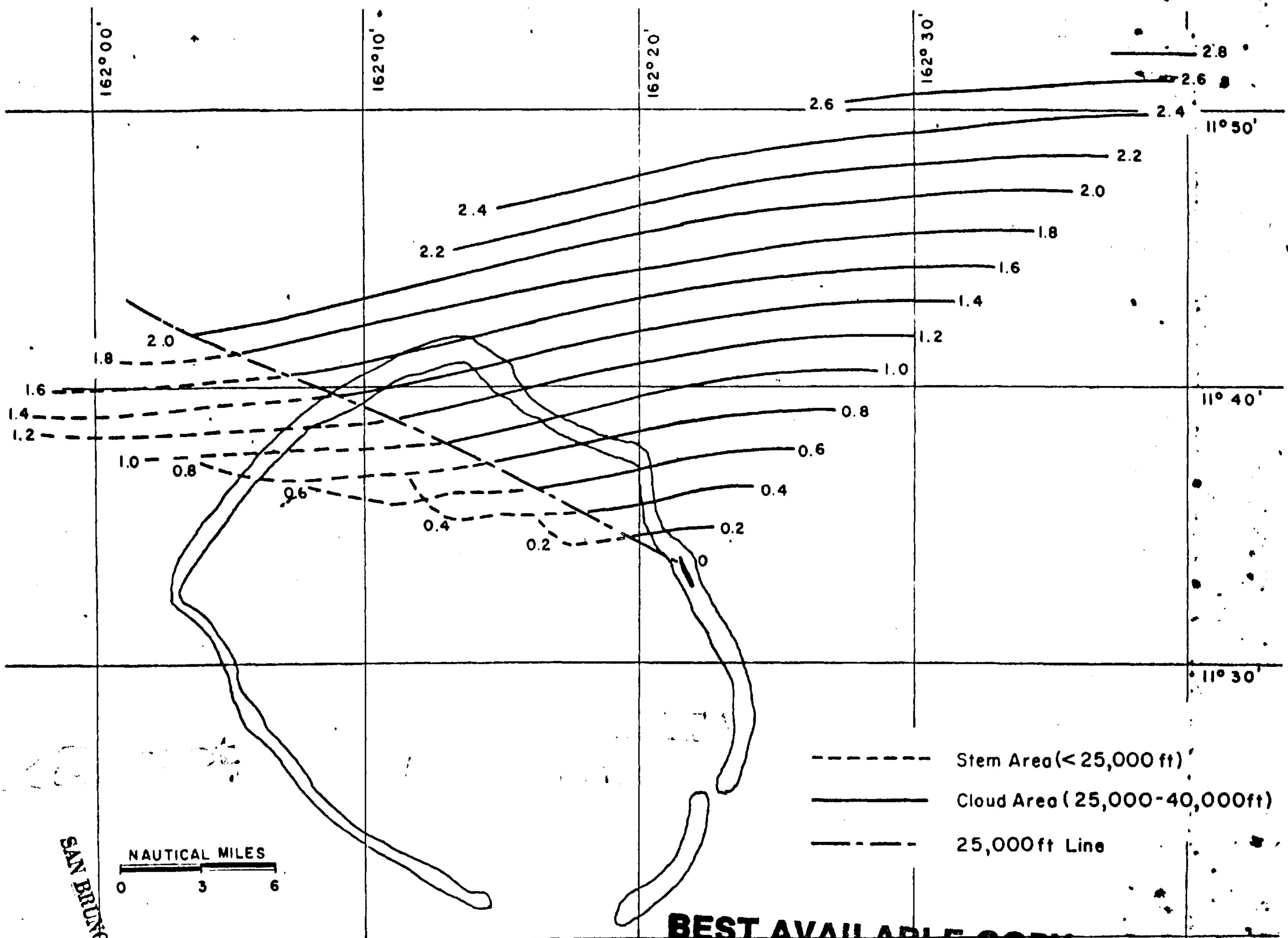

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Figure 3.14 LaCrosse Central Time of Arrival Plot. Times in hours. [redacted]

event, but these contours can be used to compare total exposure measurements with exposure rate measurements, and hence are presented here for convenience only.

3.1.2.6 Cross Decay ~~Curves~~ Exponent. Project 2.65 measured separately the gamma and beta decay curves of the LaCrosse fallout samples over the period from 30 hours to 530 hours. The decay exponent of the gamma exposure rate was observed to be 1.3 and of the beta intensity (counts per minute) 1.2. The gamma exposure rate readings in the field had a decay exponent of 1.4.

3.1.3 Mohawk

3.1.3.1 Introduction. The Mohawk device was detonated on a 300 foot tower at Site Ruby on 3 July 1956, at 0606M. The yield of the weapon was measured to be [redacted] of which [redacted] Since the fireball radius was greater [redacted] the local contamination produced by the Mohawk Shot should be at least [redacted] that produced by the same yield surface burst. To correct for tower height and the

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Program 2 participation in the Mohawk event was limited to the Project 2.65 helicopter probe aerial survey.

3.1.3.2 Particle Fall Plot. Since only the close-in fallout was documented, the particle fall plot has been constructed for the larger particles only and was not corrected for any space and time variations of the wind profile. Figure 3.15 represents the particle fall plot for the Mohawk Shot time winds and is, of course, subject to the limitations

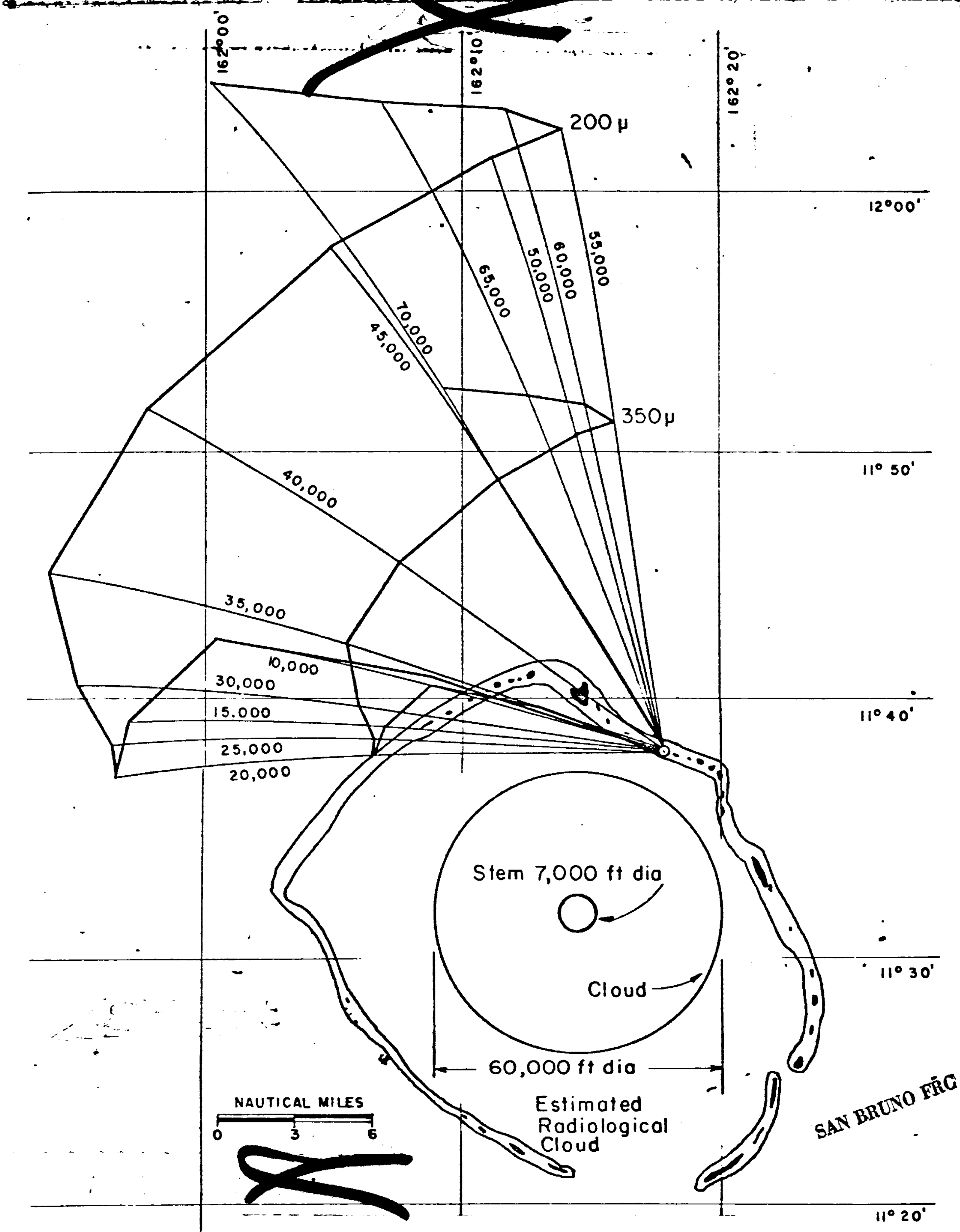

Figure 3.15 Mohawk Particle Fall Plot.

100

of accuracy and interpretation discussed in Section 3.1.1.3.

3.1.3.3 Land Equivalent Distribution of Fallout. Three foot high exposure rate readings were available from the Project 2.65 survey as well as the RadSafe survey of the contaminated islands. Both sets of readings were extrapolated to H+1 hour by using a $t^{-1.0}$ decay equation. The RadSafe readings at 25 feet and 50 feet altitude were converted to 3 feet readings by multiplying by 2.5 and 3.2, respectively. The resultant exposure rates are plotted as data points on a map in Figure 3.16. The observed field gamma exposure rate decay exponent was 1.1. It is interesting to note that readings near the crater, extrapolated to H+1 hour, in many cases exceeded 10,000 r/hr. These values are higher than any previous extrapolated values based on D-day measurements.

3.1.3.4 Central Time of Arrival Contours. The constructed central time of arrival contours are presented in Figure 3.17. There was no data taken relative to such measurements and these contours are presented for convenience in drawing conclusions about total exposure only.

3.1.4 Tewa.

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3.1.4.1 Introduction. The Tewa device was detonated on a barge in shallow water over the lagoon reef between Sites Charlie and Dog, Bikini Atoll, at 0546M, 21 July 1956. The yield of the device was measured to be [redacted] of which [redacted]

The environment prior to firing Tewa is illustrated in Figure 3.18. Aerial photographs show that a crater of about 3,200 feet in diameter was produced in the reef. Considering the shallowness of the water over the reef (0-60 feet), the explosive size of the weapon, and the crater size, Tewa is considered as a land surface shot. With careful analysis it may be found that the lagoon water introduced differences in the effects anticipated from a land surface burst. However, it is expected that these differences will be small.

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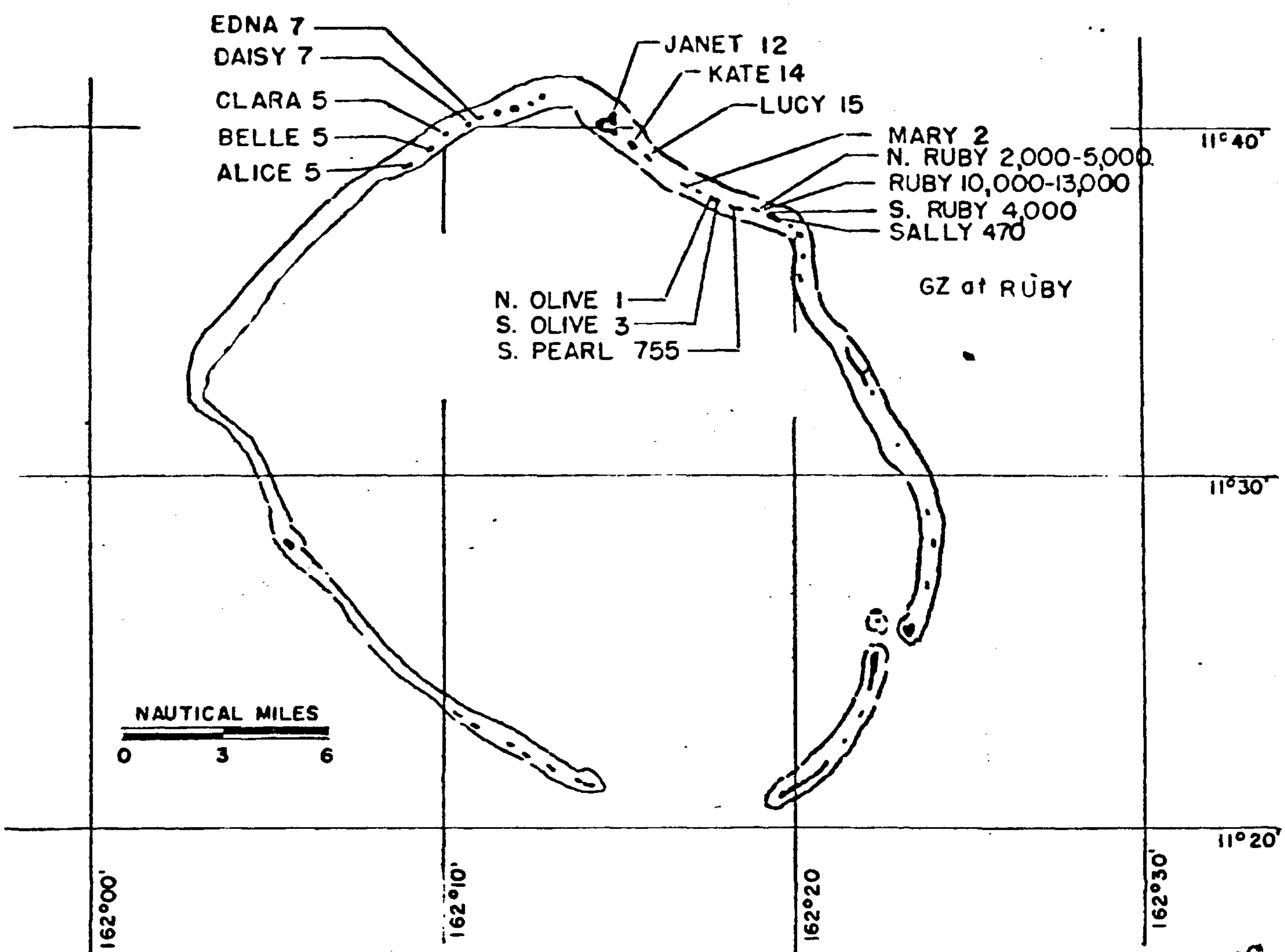

Fig 3.16

Figure 3.16 Mohawk Fallout Radiation Plot. H+1 Hour equivalent land exposure rates in r/hr.

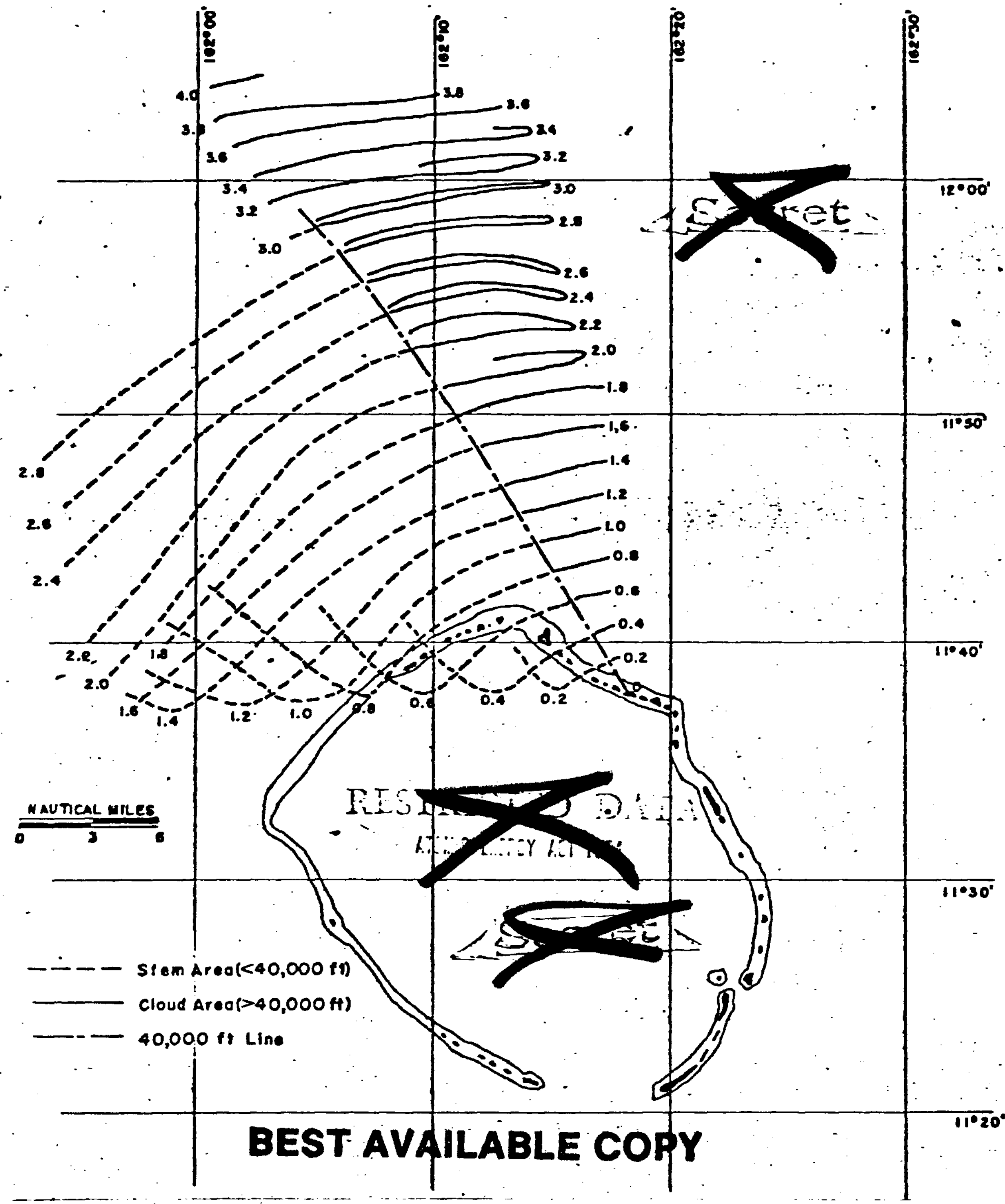

Figure 3.17 Mohawk Central Time of Arrival Plot. Times in hours.

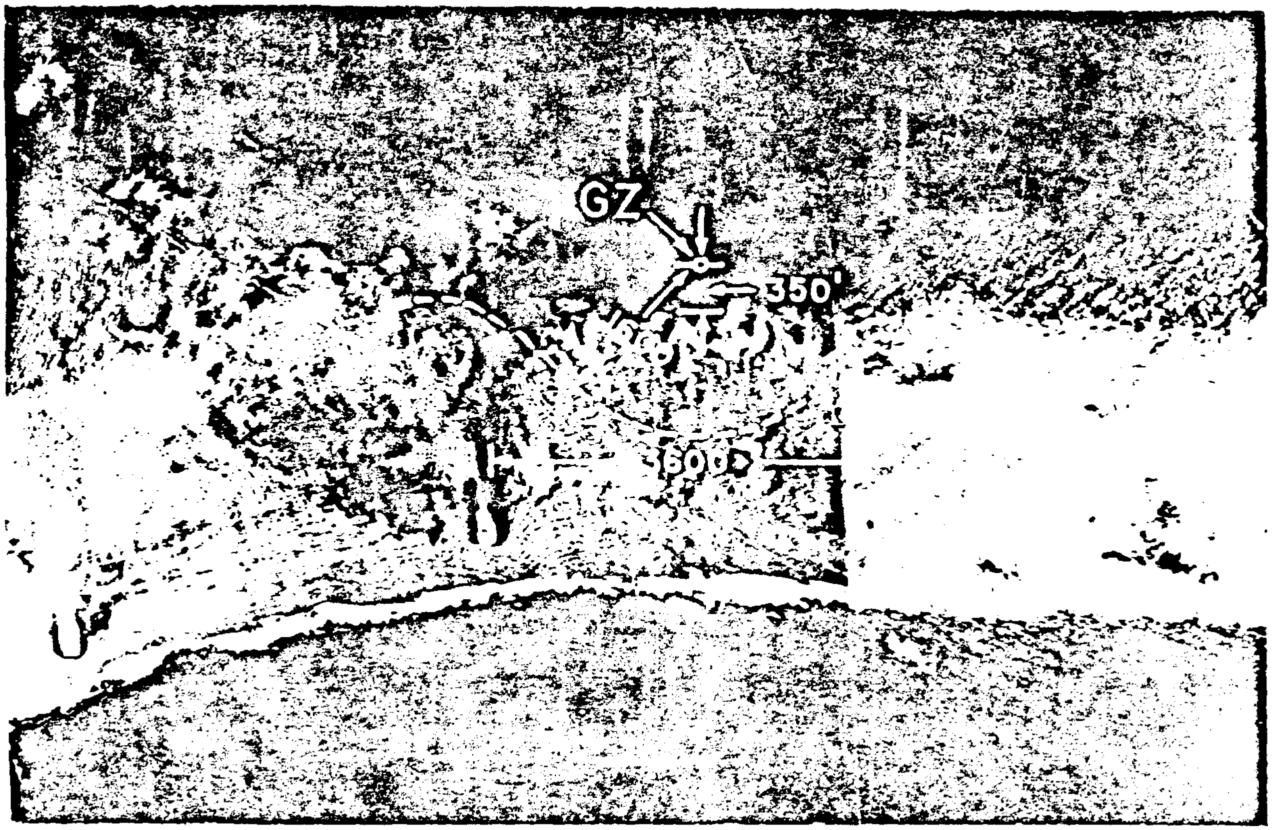

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Figure 3.18 Aerial View of Reef Between Sites Charlie and Dog with an Overlay of the Tewa Crater.

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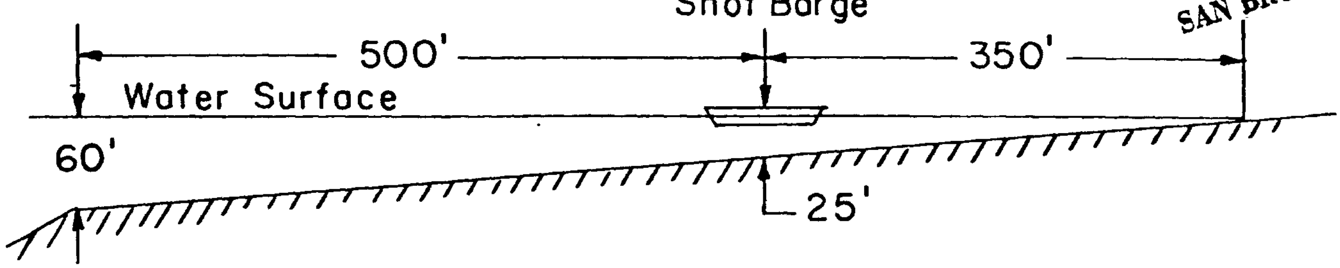

3.1.4.2 Distribution of Activity in the Stabilized Cloud. Limited radiation measurements were made in the nuclear cloud with four (4) rockets fired at about H+7 minutes. Subject to the limitations given in Section 3.1.1.2, the reduced radiation rate readings from the only record analyzed in the field are presented in Figure 3.19. A view showing the location of the plane of the rockets in the cloud is presented in Figure 3.20. The dimensions which were used were obtained from photographs of the Navajo mushroom taken at H+8 minutes.

3.1.4.3 Particle Fall Plot. Figure 3.21 represents the particle fall plot for the winds measured at and after shot time for the Tewa event. The comments and limitations previously given in Section 3.1.1.3 are equally applicable to this plot.

3.1.4.4 Characterization of Fallout Material. In general, the fall-out material closely resembled that from the Zuni Shot as well as that from CASTLE Bravo. Particle size and chemical analyses will be performed almost exclusively in continental laboratories and therefore such data was not available at the time of writing of this report.

3.1.4.5 Land Equivalent Distribution of Fallout [illegible]. The fall-out documentation projects in Program 2 participated fully in the Tewa event and the radiation data from the collection of material and surveys is summarized in Figure 3.22. The data are from the same sources and were treated in the same manner as discussed in Section 3.1.1.5. The radiation versus depth profiles indicated an effective depth of penetration of activity in the ocean water varying linearly from 20 meters at 10 hours to 62 meters at 38 hours and remaining constant beyond this time. The decay exponent measured in the decay tank on the M/V HORIZON

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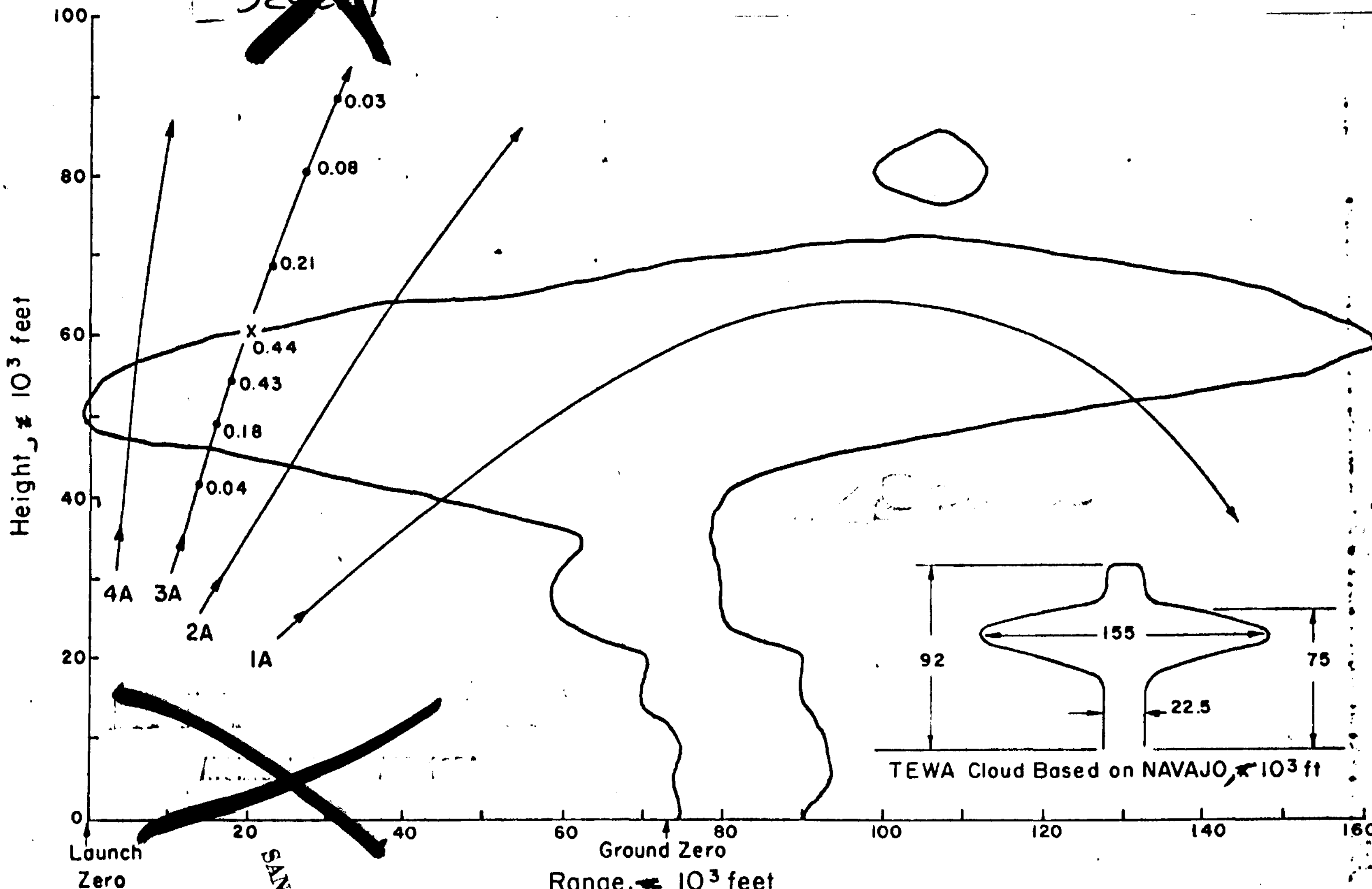
Figure 3.19 Tewa Cloud at H+7 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.



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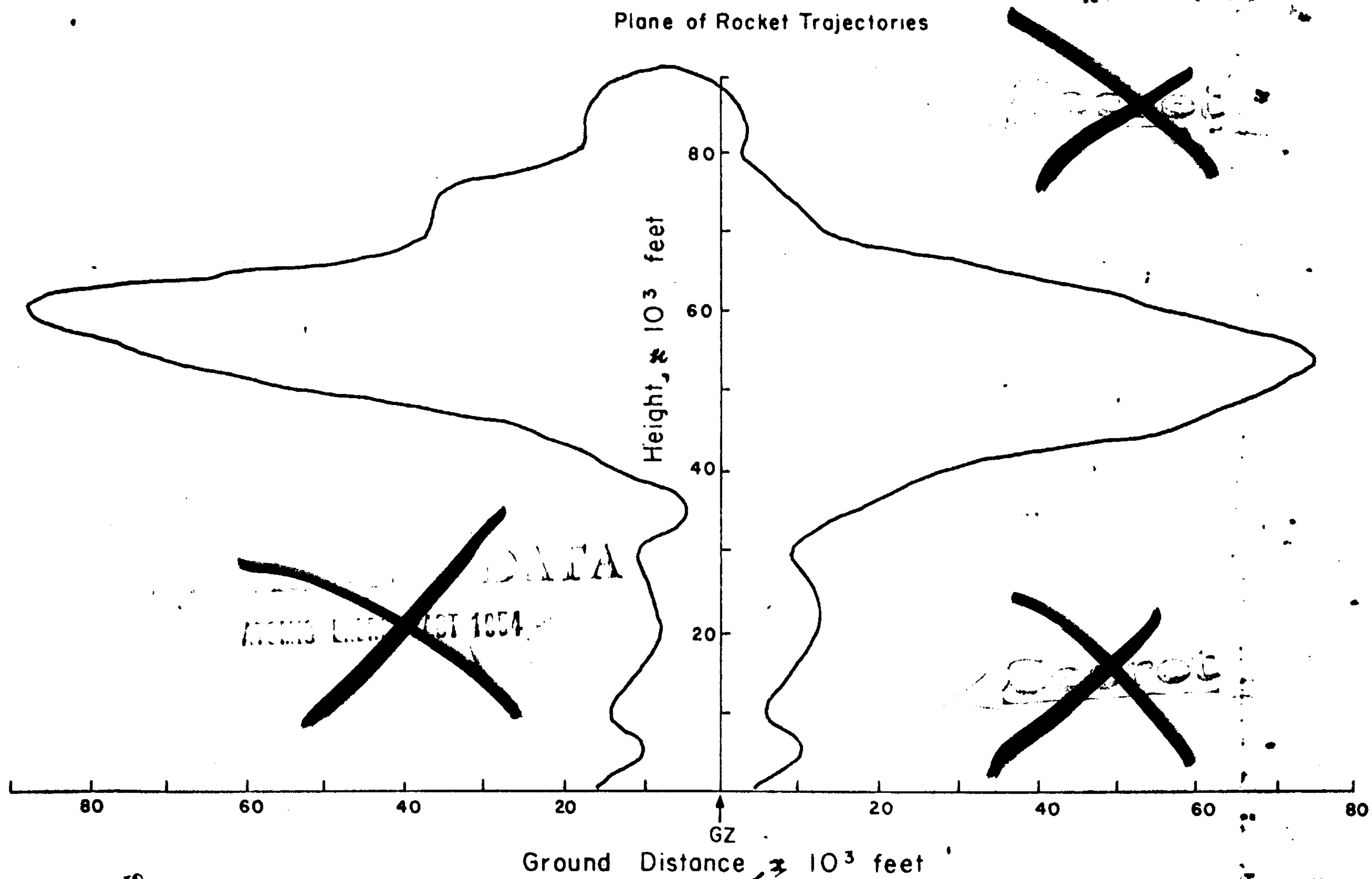
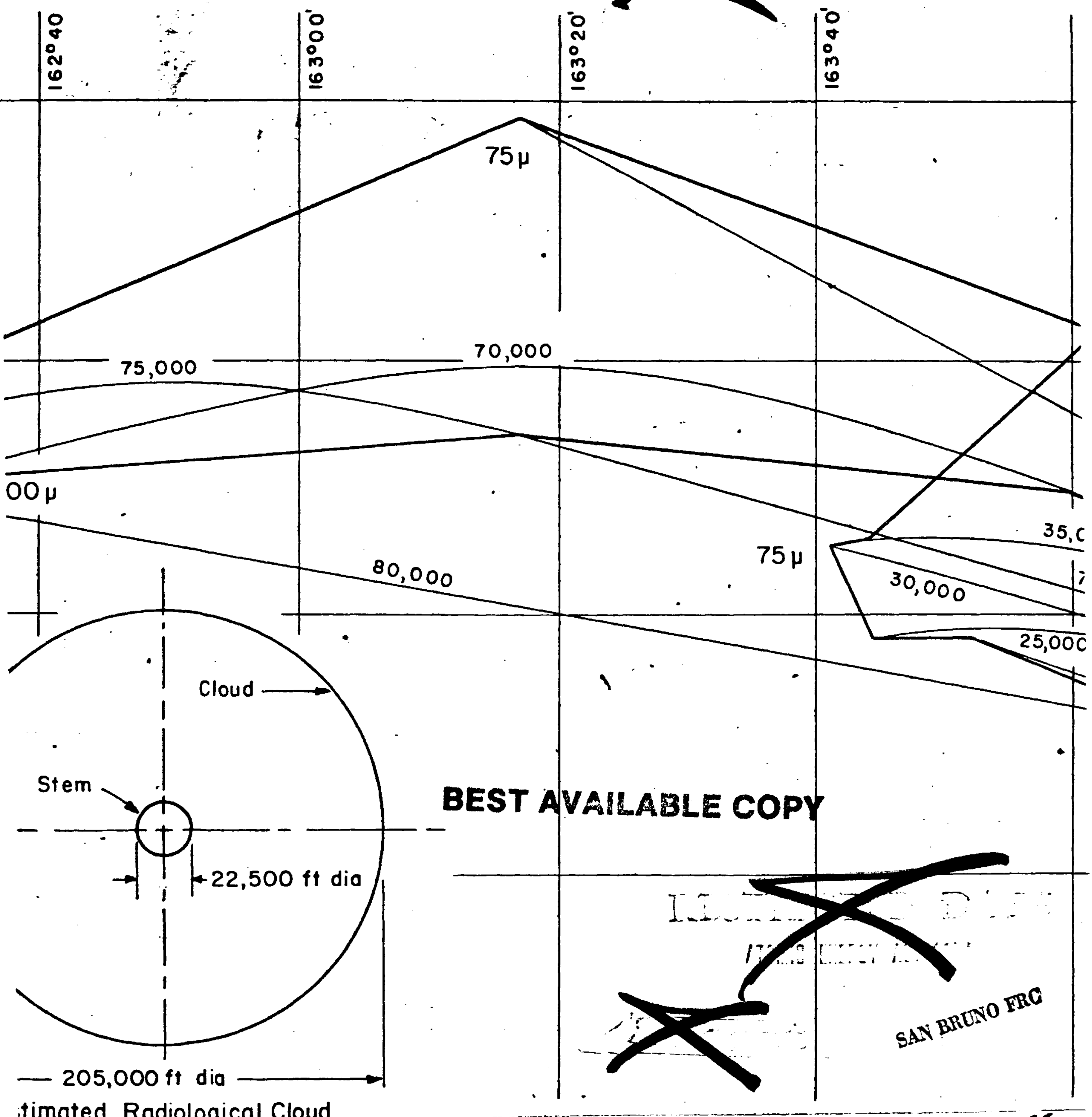


Figure 3.20 Looking Along Plane of H+7 Minutes Rockets Toward Tewa Cloud.

107



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92 Figure 3.21 Tewa Particle Fall Plot.

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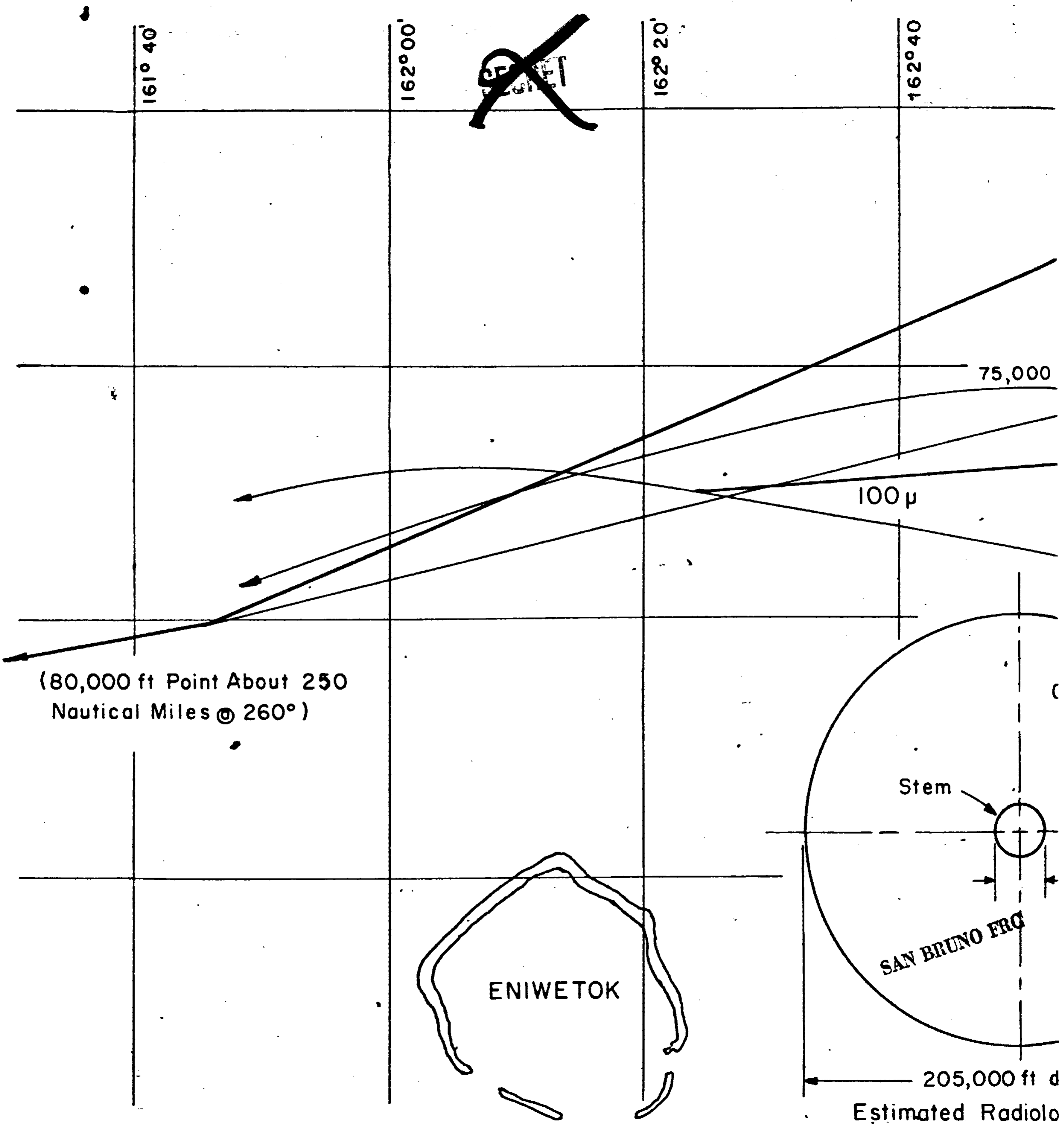

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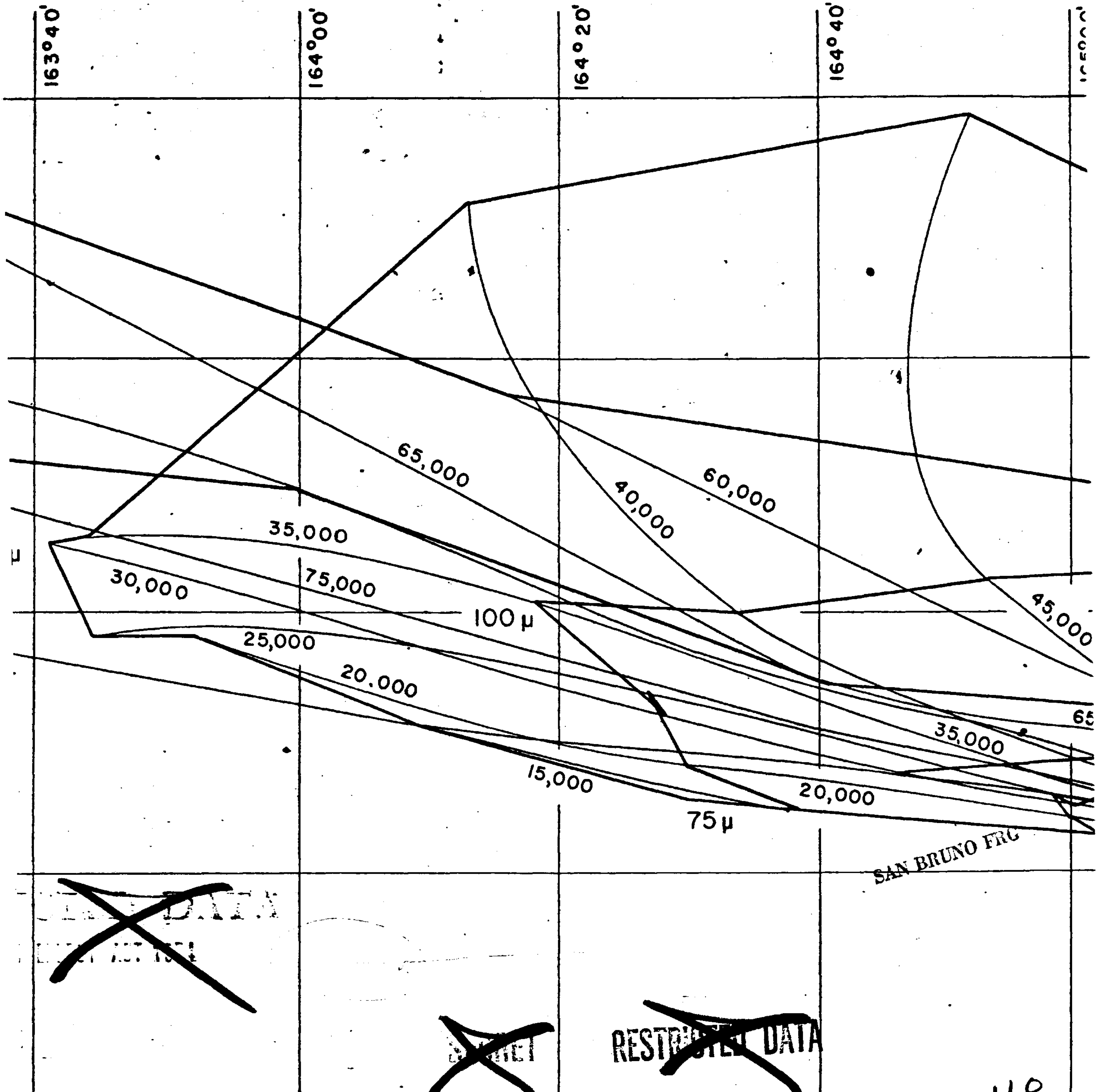

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ticle Fall Plot.

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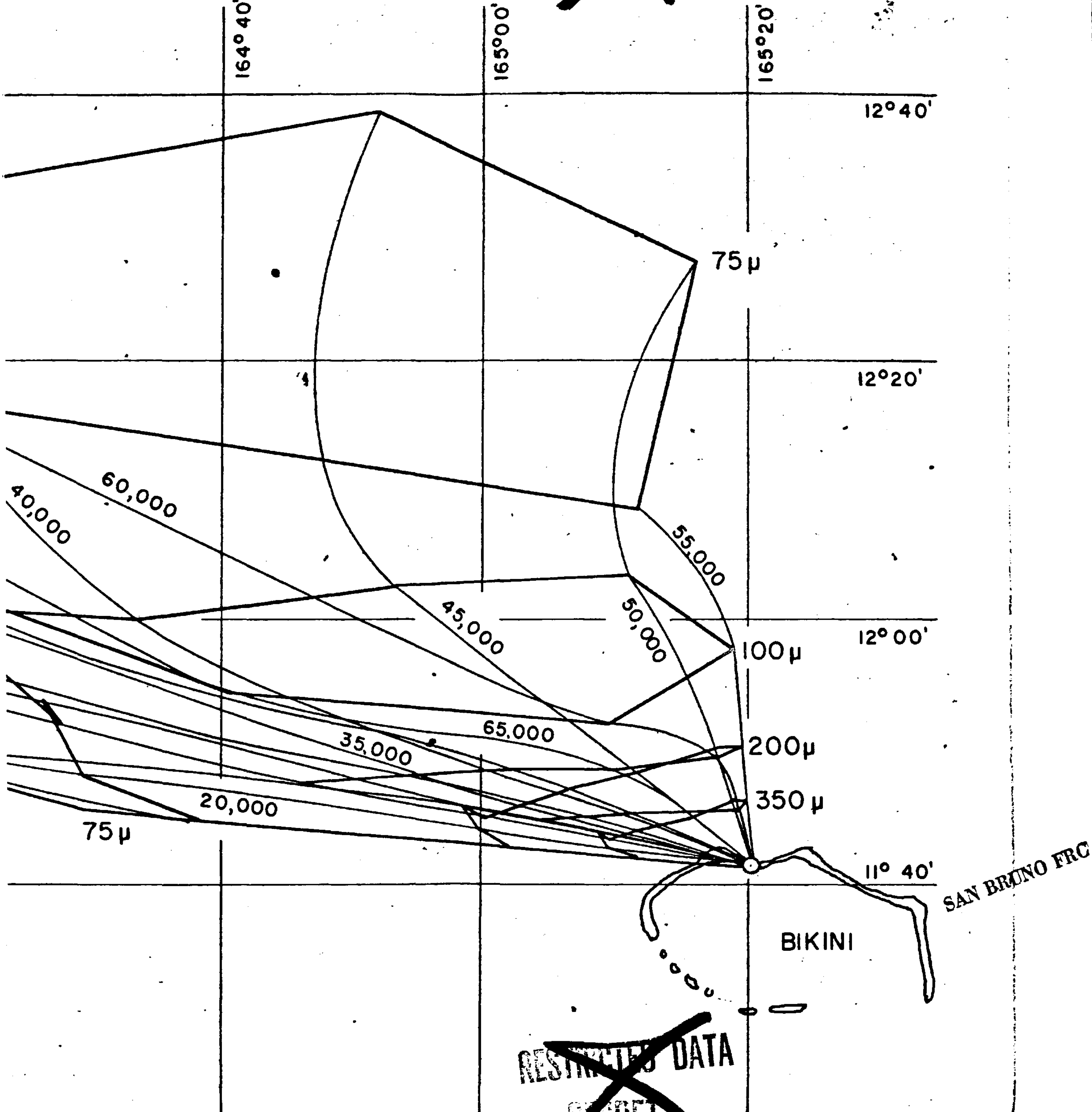

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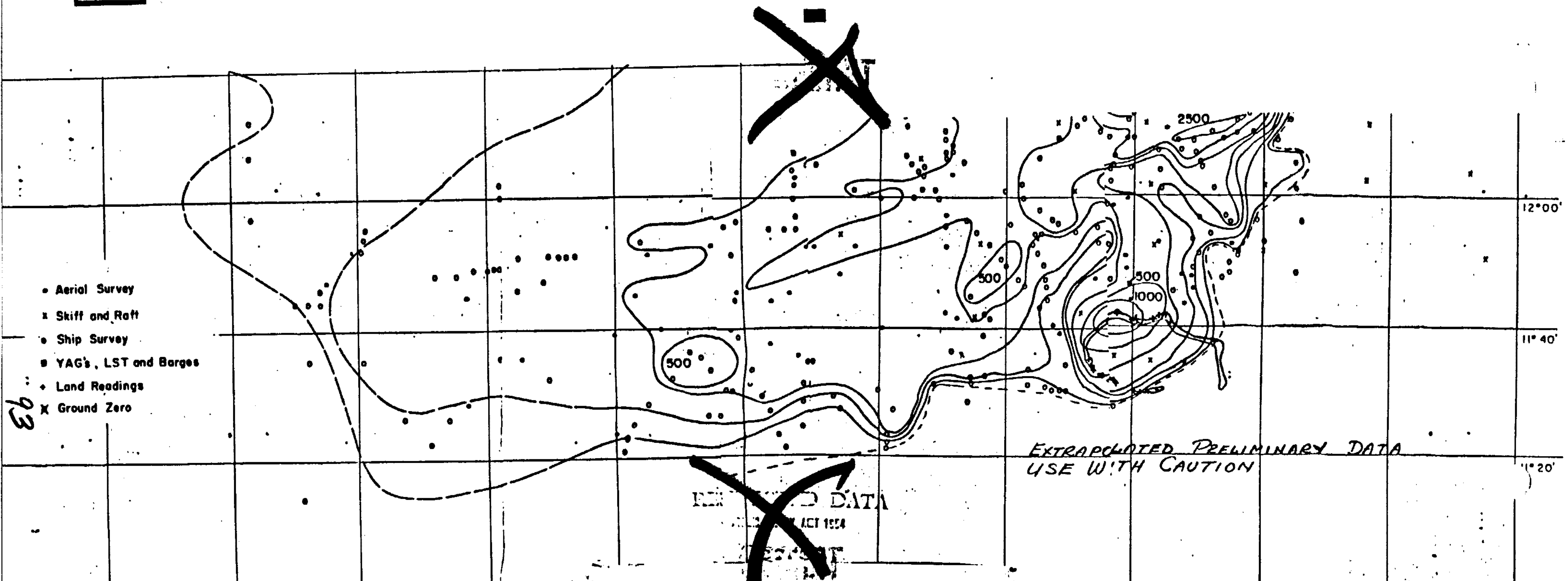
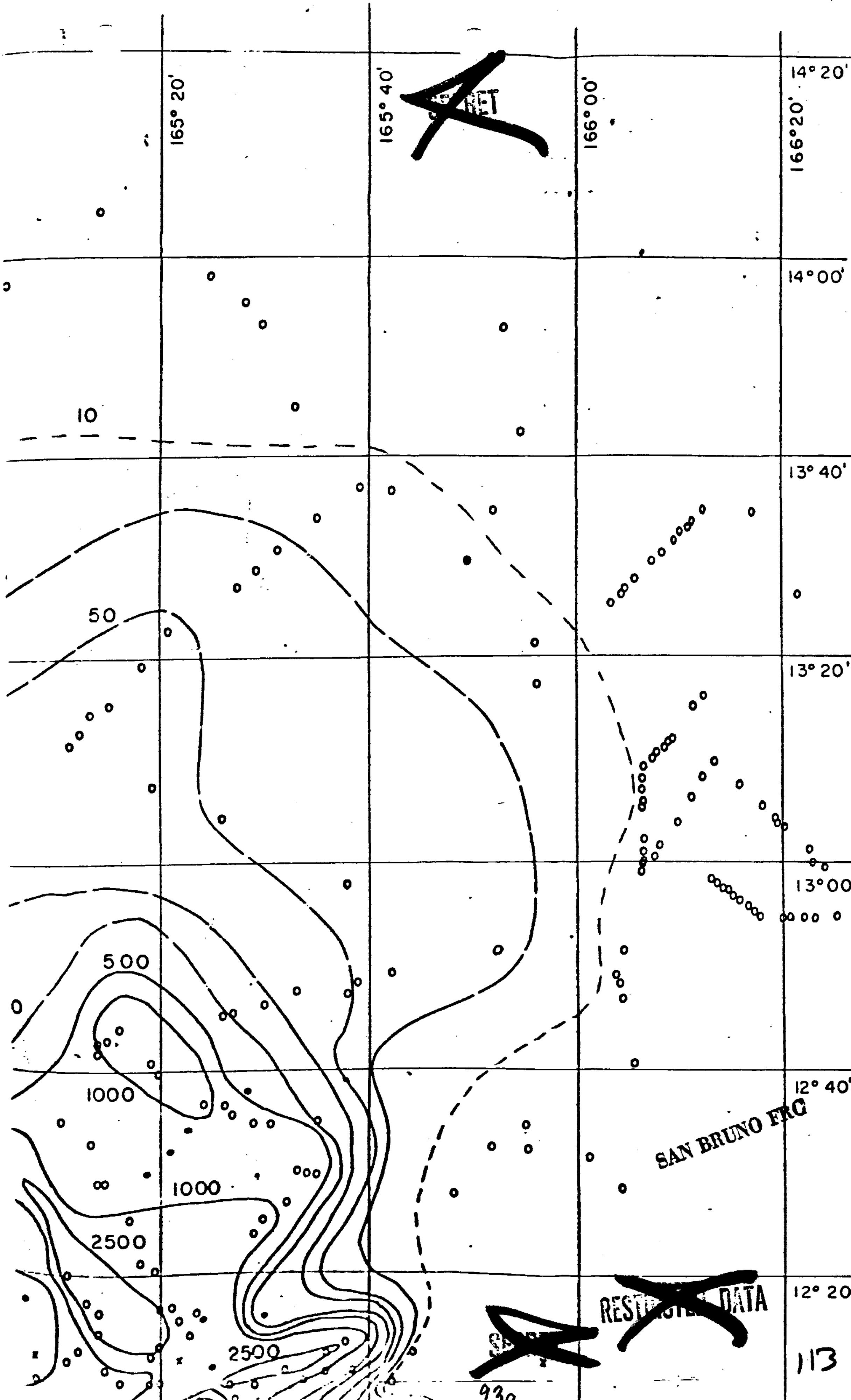
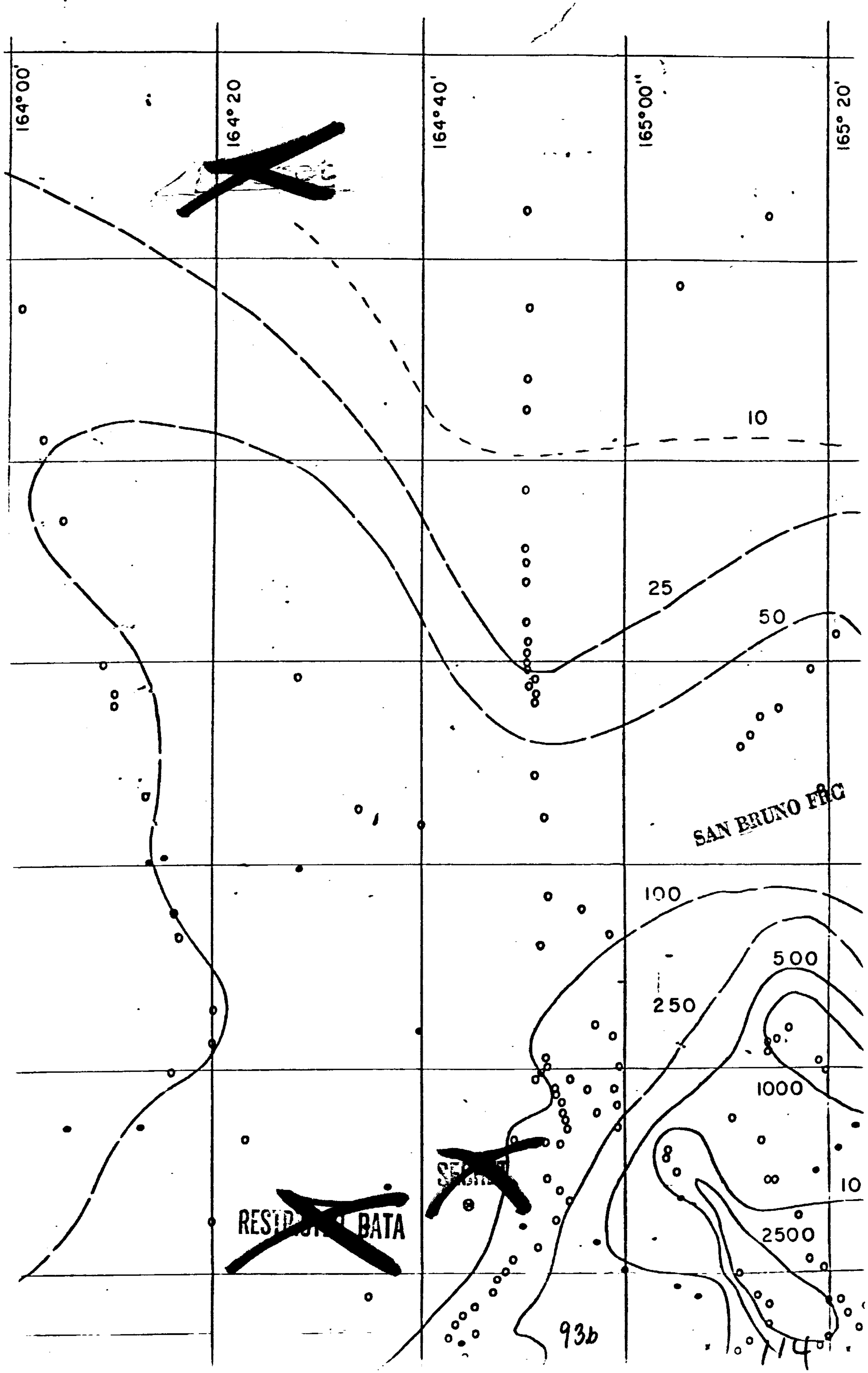


Figure 3.22 Yoke Fallout Radiation Plot. H/1 hour equivalent land exposure rates in r/hr. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.


165° 20'
165° 40'
166° 00'
166°20'
14° 20'
14°00'
13° 40'
13° 20'
13°00'
12° 40'
12° 20'
10
50
500
1000
1000
2500
2500


164°00'
164°20
164°40'
165°00'
165°20'
10
25
50
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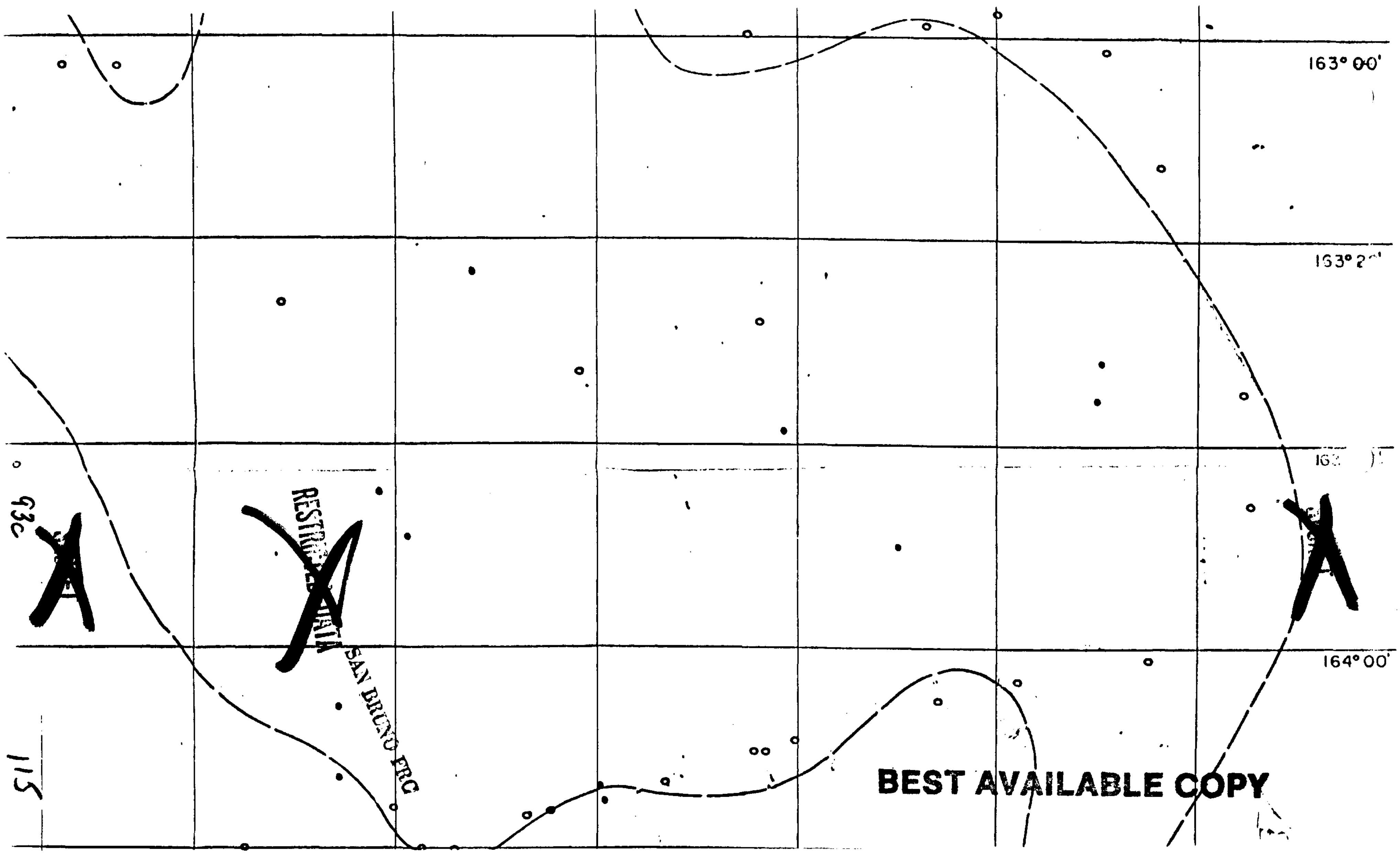
100
500
250
1000
2500
93b
114



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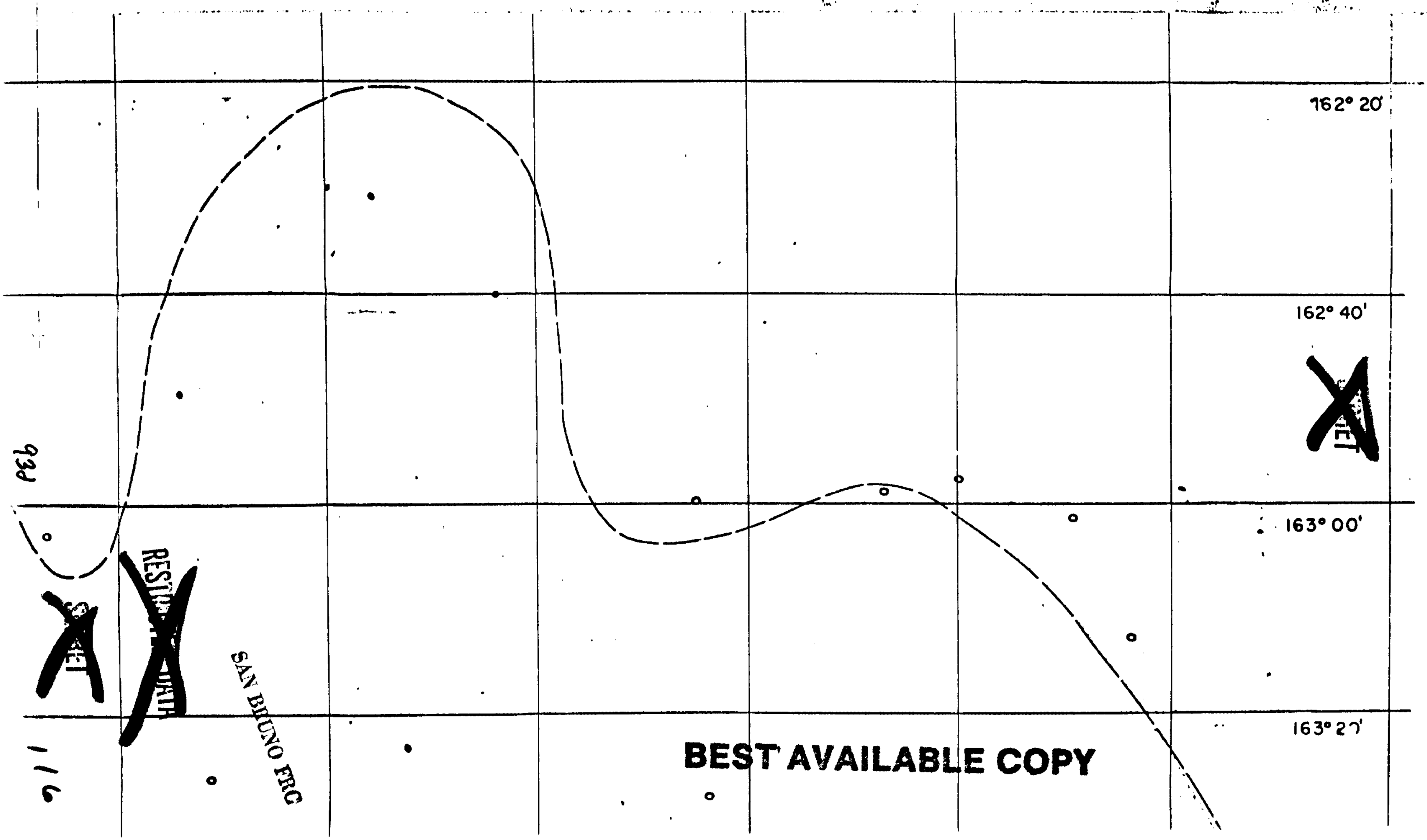

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was 1.34. These depth of penetration and decay exponent values were used in reducing the water survey and the P2V aircraft survey readings to the land equivalent exposure rates as presented in the contours of Figure 3.22. The uncertainties in this procedure caused by the particulate nature of the fallout from a land surface burst have already been discussed in Section 3.1.1.5.

3.1.4.6 Central Time of Arrival Contours. The central time of arrival contours shown in Figure 3.23 were constructed as discussed in Section 3.1.1.6 and the same sources provided the data points.

3.1.4.7 Ten Hour Exposure Contours. The ten hour exposure contours and Project 2.1 data points are presented in Figure 3.24. The discussion of Section 3.1.1.7 is applicable to this figure.

3.1.4.8 Gross Decay ~~Curves~~ Exponent. The characteristic beta and gamma decay exponents observed after the Tewa shot are summarized in Table 3.3. These should be interpreted in view of a reported Np^{239} capture to fission ratio of about 0.5. It should be emphasized that these are all preliminary values based on only part of the data and do not completely reproduce the shape of the decay curve.

TABLE 3.3 GROSS DECAY EXPONENTS FOR TEWA

	Time (Hours)	5–20	20–50	50–200
Decay Exponent	Gamma Photons*	0.7	0.7	-
	Gamma Exposure Rate	-	0.8–1.0	-
	Beta dis/min	0.9	0.9	-
	Field Gamma Exposure Rate	-	1.1	-
	Gamma Exposure Rate in Water	-	1.34	-

NOTE: *YAG 40 samples only.

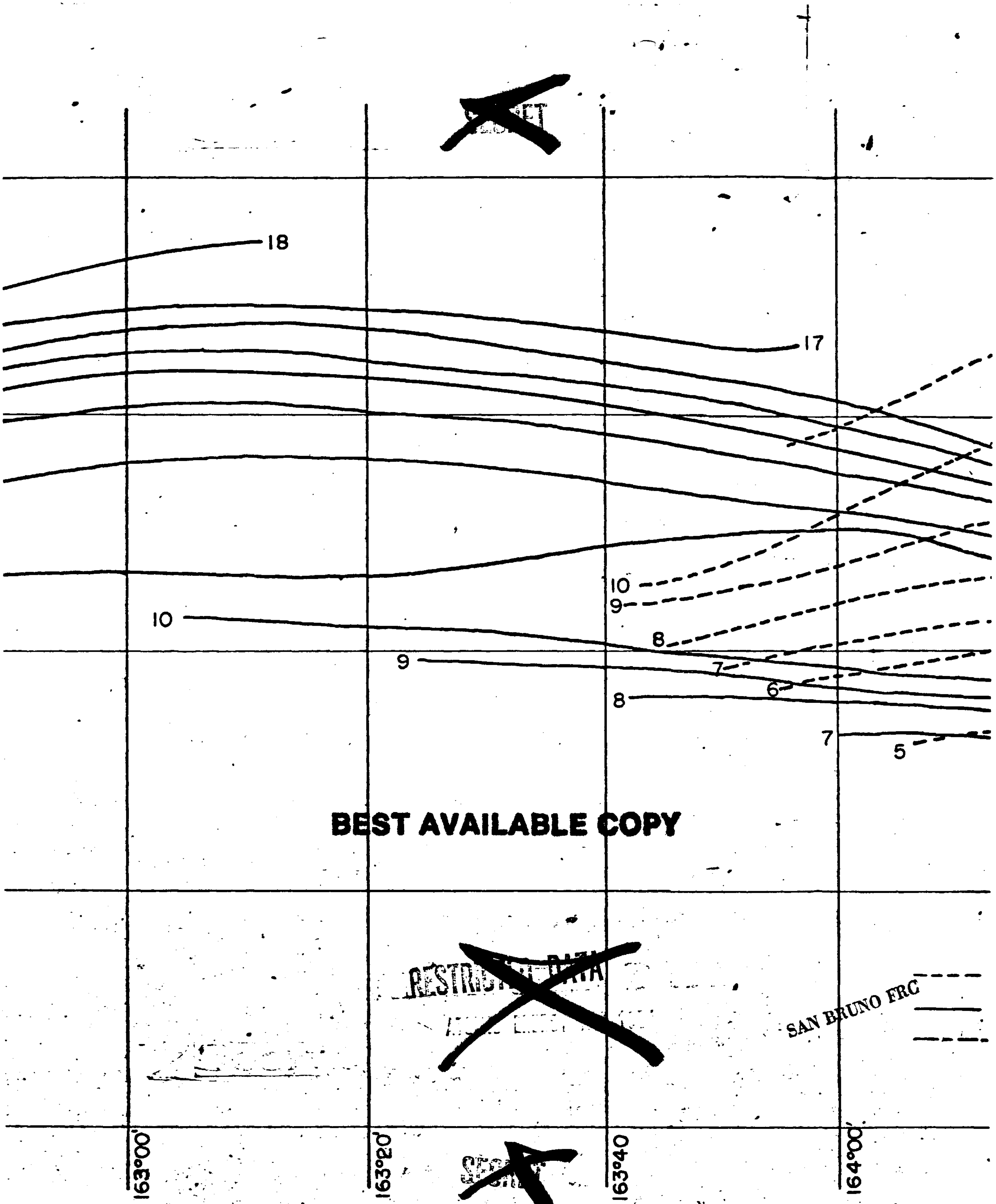

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Figure 3.23 Tewa Central Time of Arrival Plot. Times in hours.

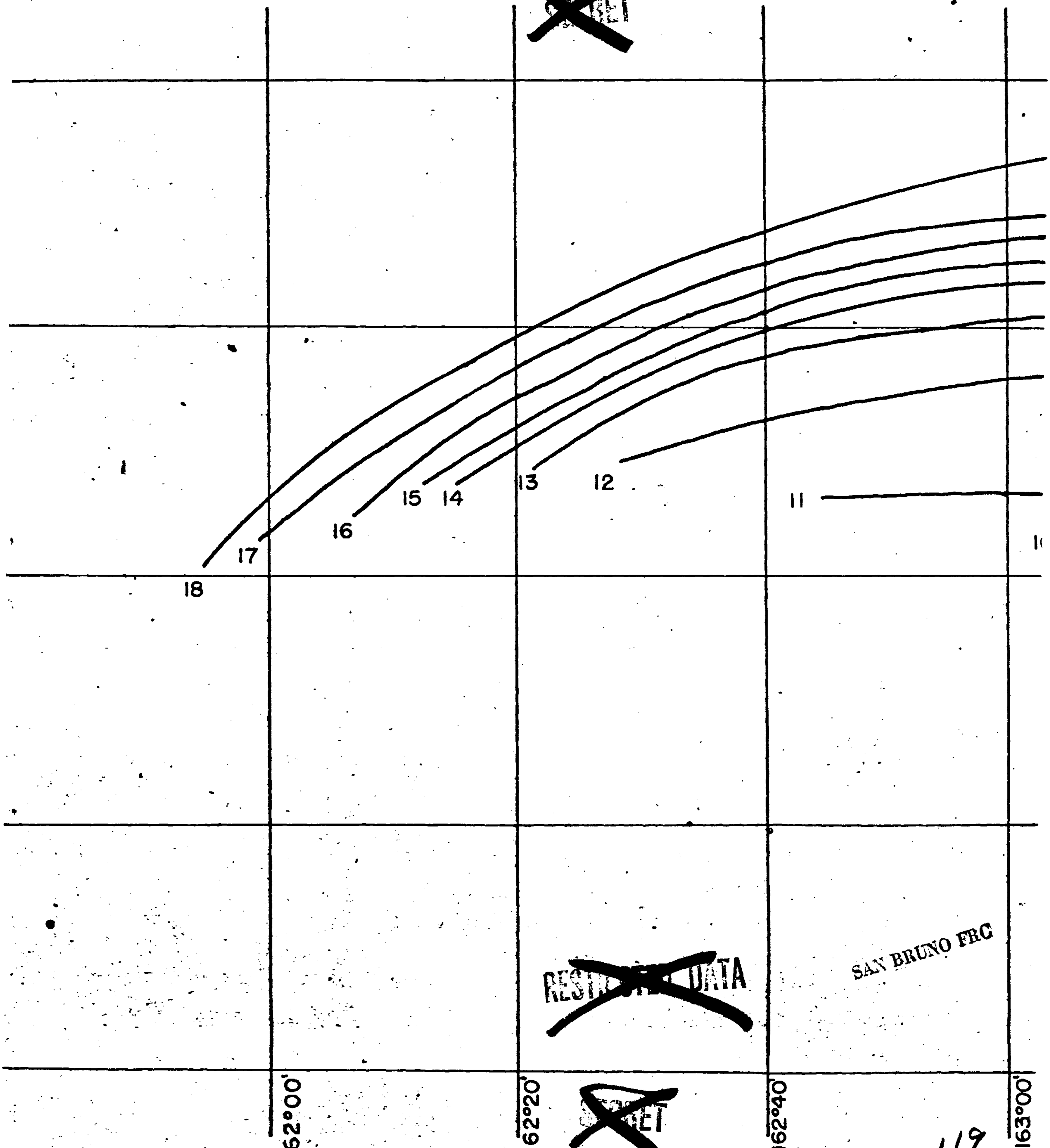

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Figure 3.

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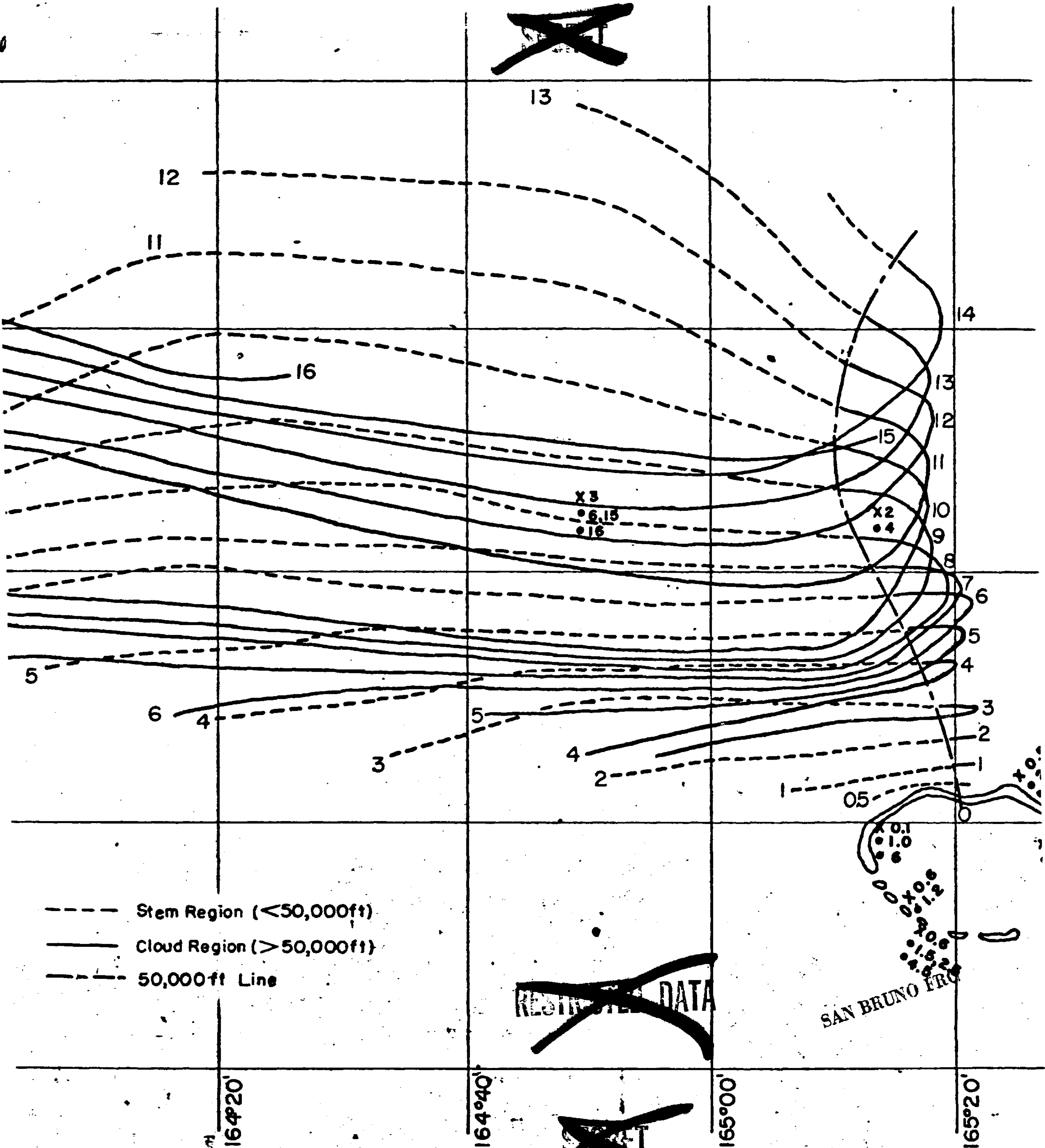
Stem Region (<50,000ft)
Cloud Region (>50,000ft)
50,000ft Line
164°20'
164°40'
165°00'
165°20'
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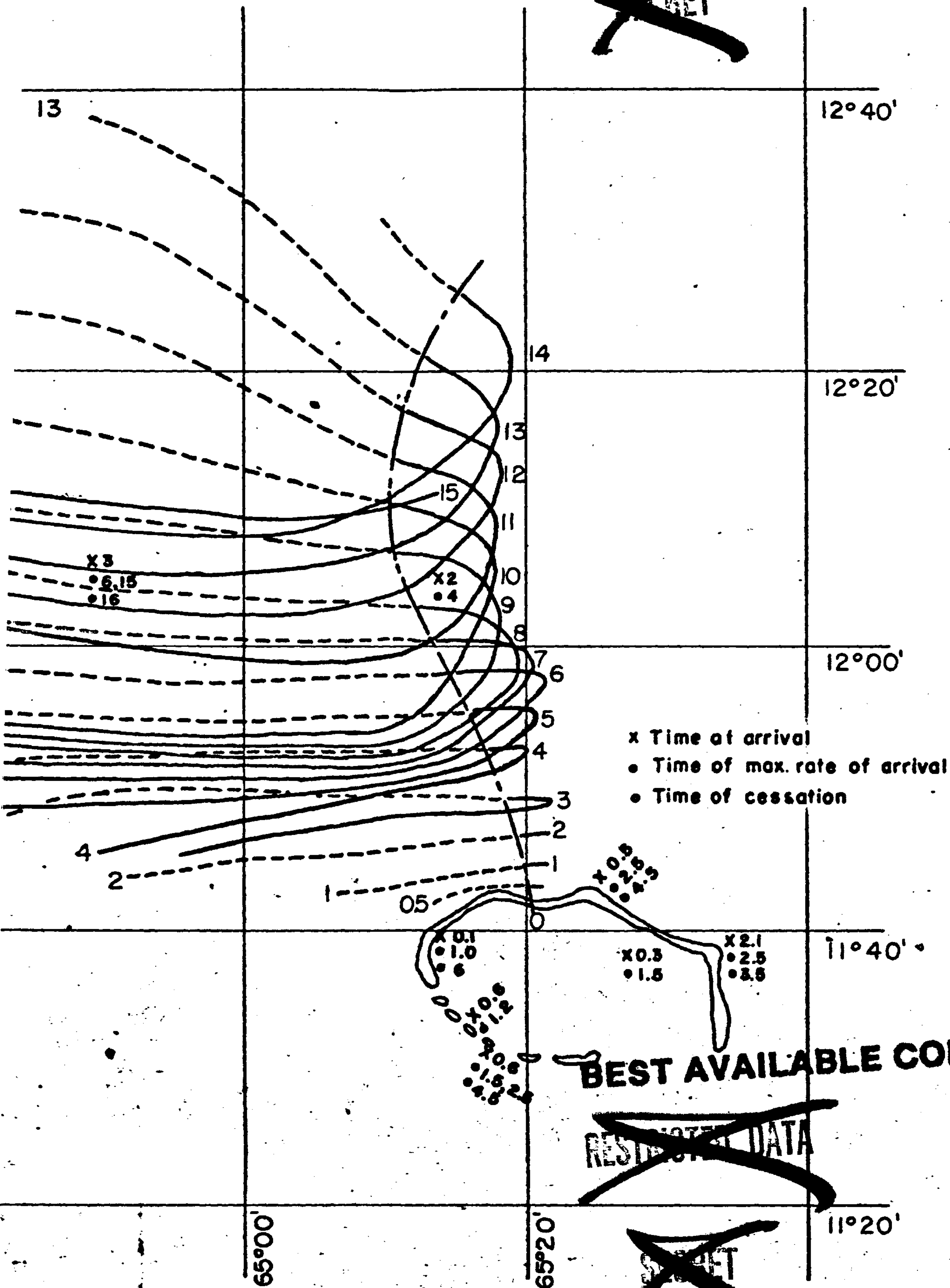
12°40'
12°20'
12°00'
11°40'
11°20'
165°00'
165°20'
x Time of arrival
• Time of max. rate of arrival
• Time of cessation
x 3
• 6.15
• 16
x 2
• 4
x 0.5
• 2.5
• 4.5
x 0.1
• 1.0
• 6
x 0.3
• 1.5
x 2.1
• 2.5
• 3.5

121

95c

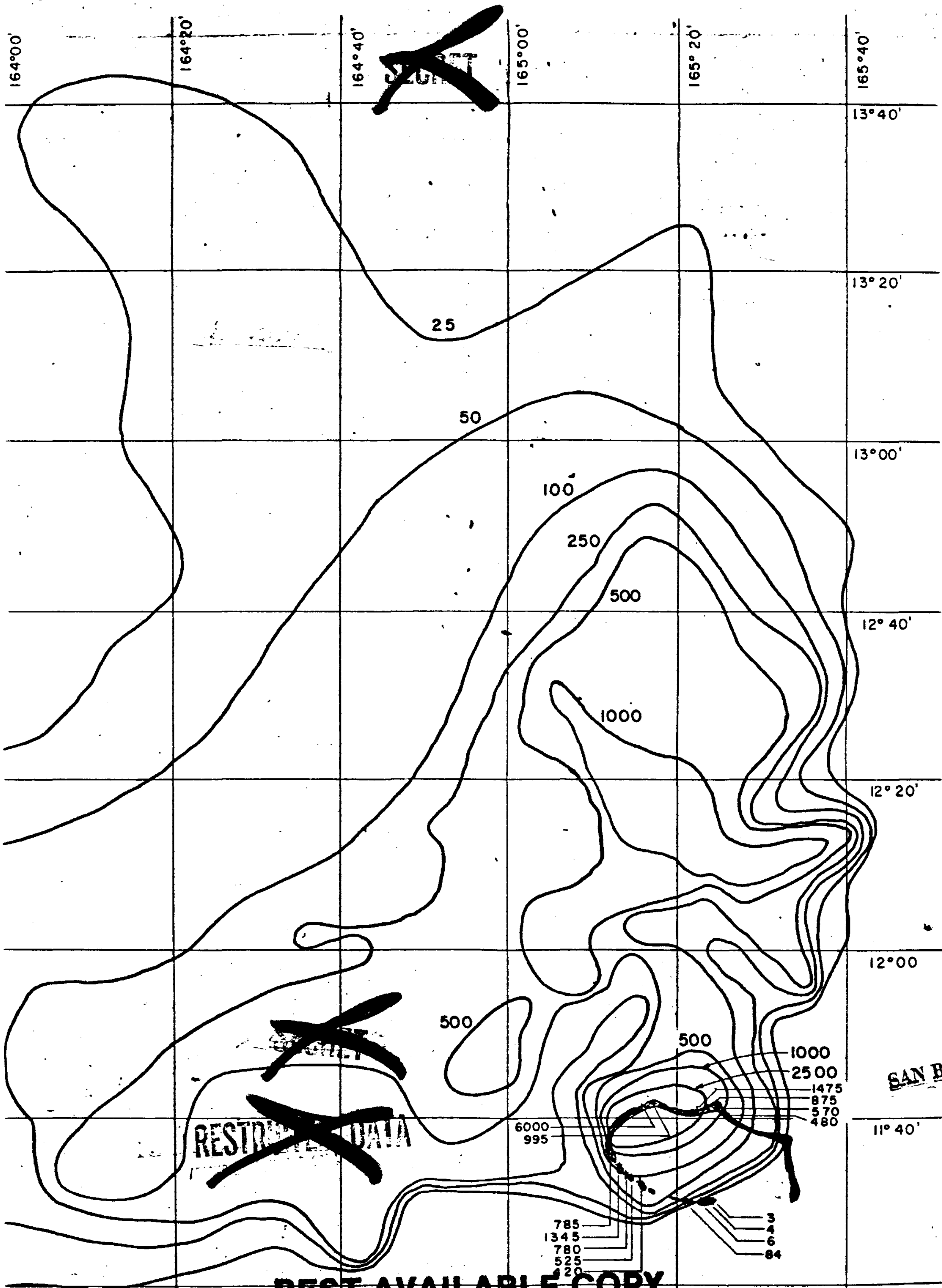

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Figure 3.24 Tewa Ten Hour Exposure Contours.
Exposures in r. Extrapolated Preliminary Data. Use with caution.

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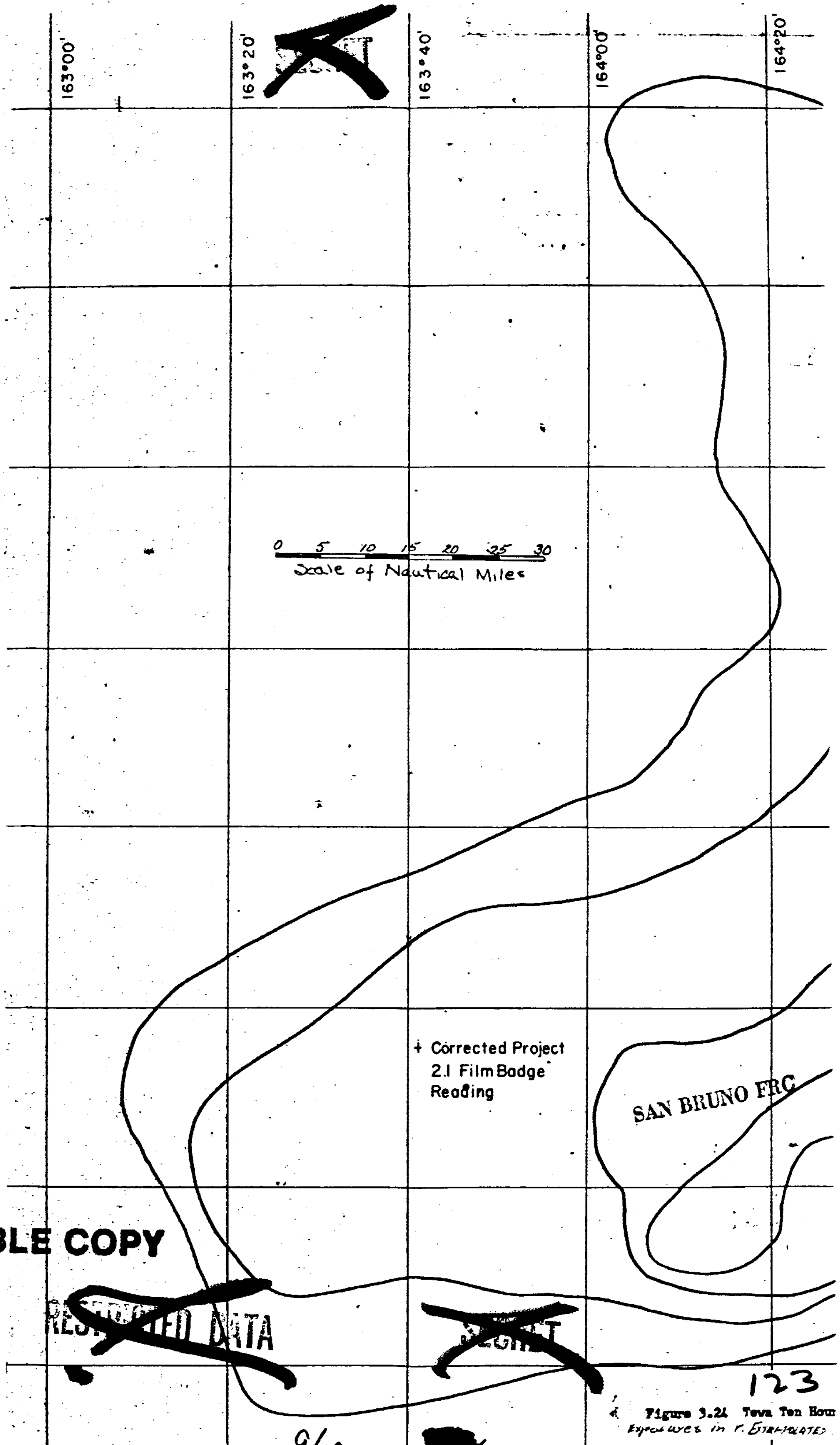

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Figure 3.24 Tewa Ten Hour
Exposures in r. Extrapolated

3.2 AIR BURSTS

3.2.1 Cherokee.

3.2.1.1 Introduction. The Cherokee device was dropped from an aircraft on 21 May 1956, and detonated at a height of about 4,500 feet at approximately 3.7 miles northeast of Site Charlie. DELETED

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DELETED The intended burst point for the weapon was directly above Site Charlie so that the fallout data was to be applicable to a minimal air burst over land. In actual fact, the weapon detonated above the deep ocean and therefore the results of the experiments must be interpreted in that light.

3.2.1.2 Distribution of Activity in the Stabilized Cloud. Two salvos of six rockets each were fired at the Cherokee cloud at H+7 minutes and H+15 minutes respectively. Since the rockets were aimed according to the intended zero point and hence were in a plane about 3.7 miles away from the actual zero point, the lower trajectories did not intercept the small stem of the nuclear mushroom. However, the large dimensions of the cloud provided sufficient opportunity for a number of good data traces. The results are plotted in Figure 3.25 and Figure 3.27 for the 7 minute and 15 minute salvos respectively, according to the method described in Section 3.1.1.2 and using the same cloud dimensions which were developed for Zuni and a somewhat smaller stem diameter. The location of the plane of the rocket trajectories through the mushroom is illustrated in Figures 3.26 and 3.28.

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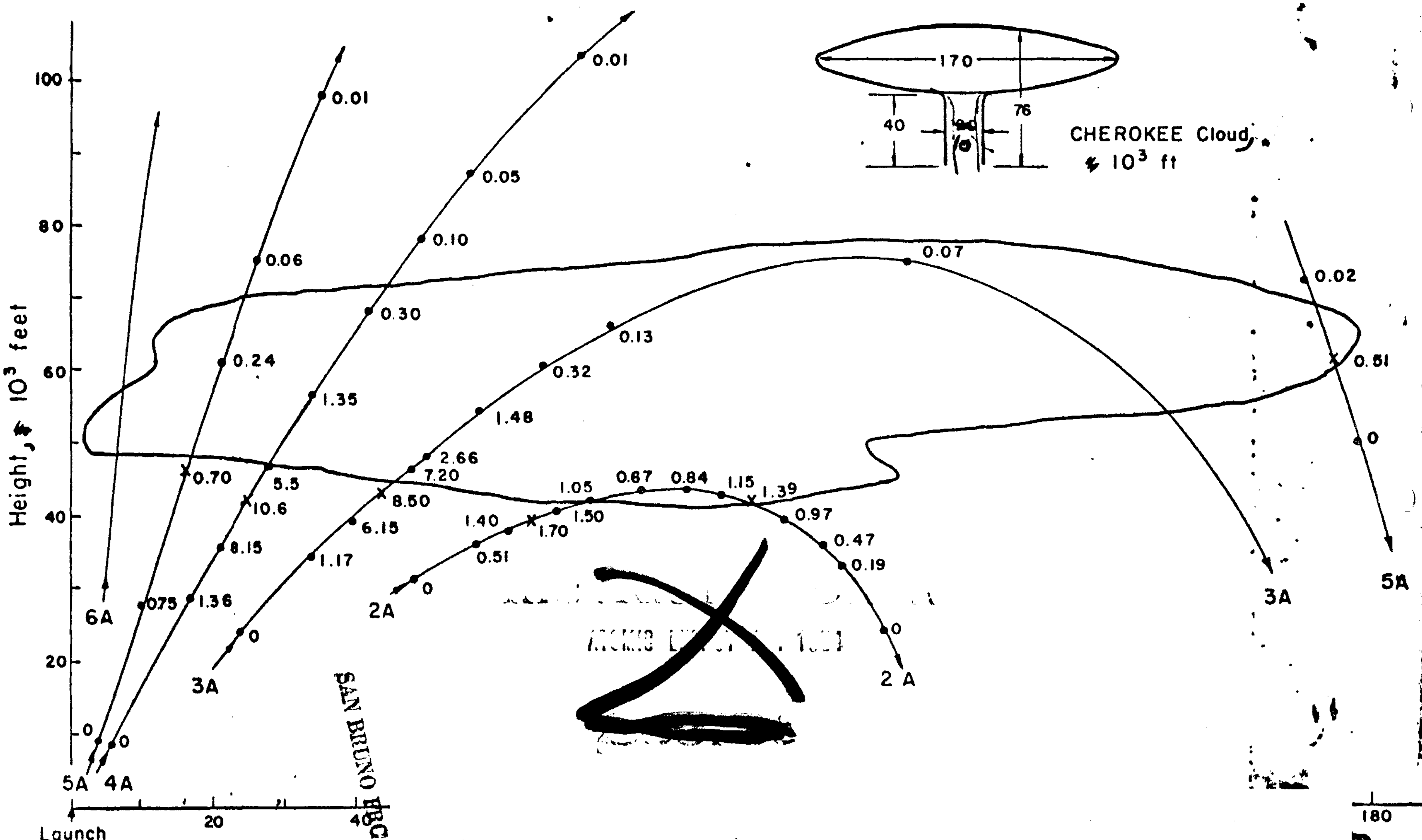

Figure 3.25 Cherokee Cloud at H+7 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.

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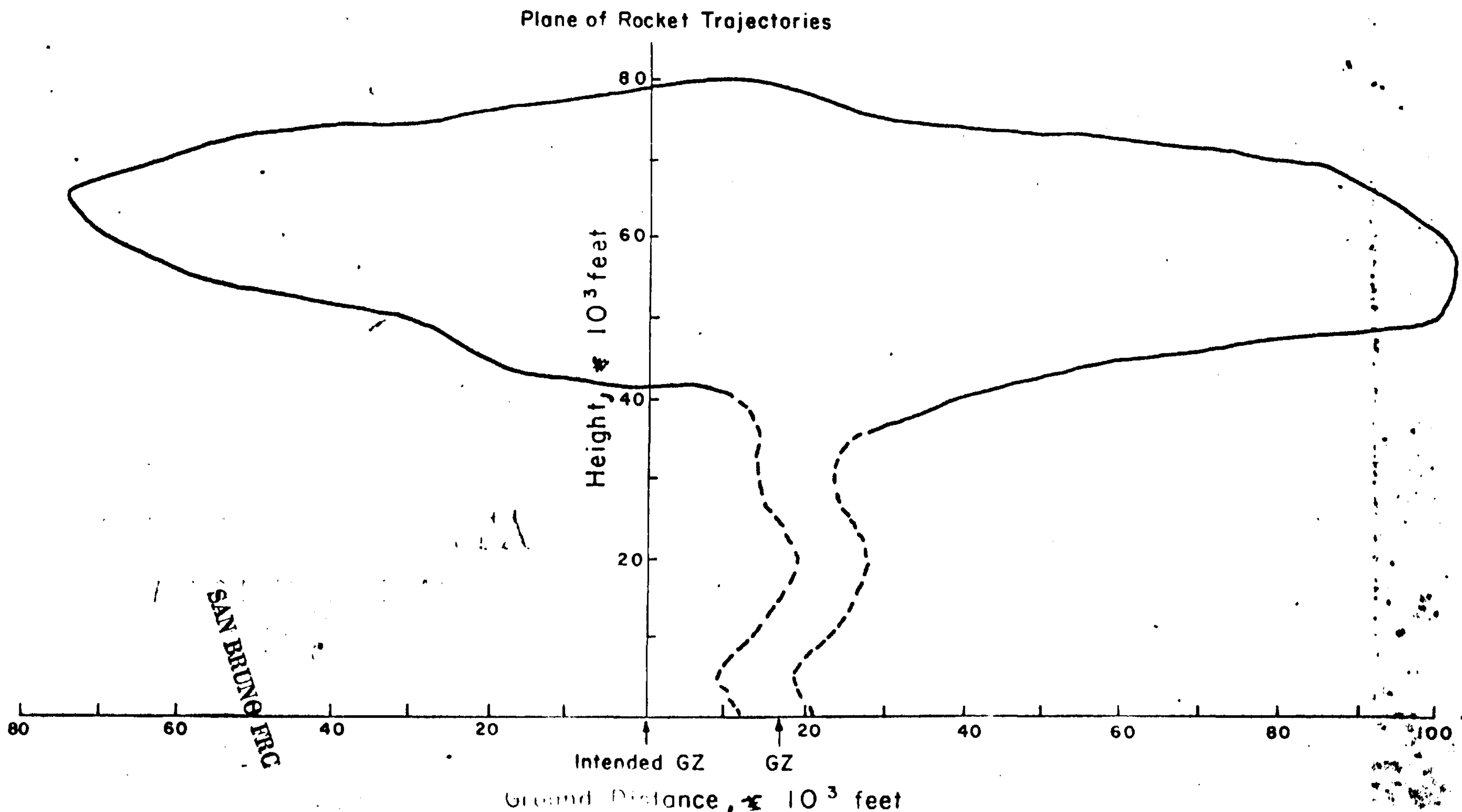

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Figure 3.26 Loading [illegible] of H/7 Minute Rockets Toward Cherokee Cloud.

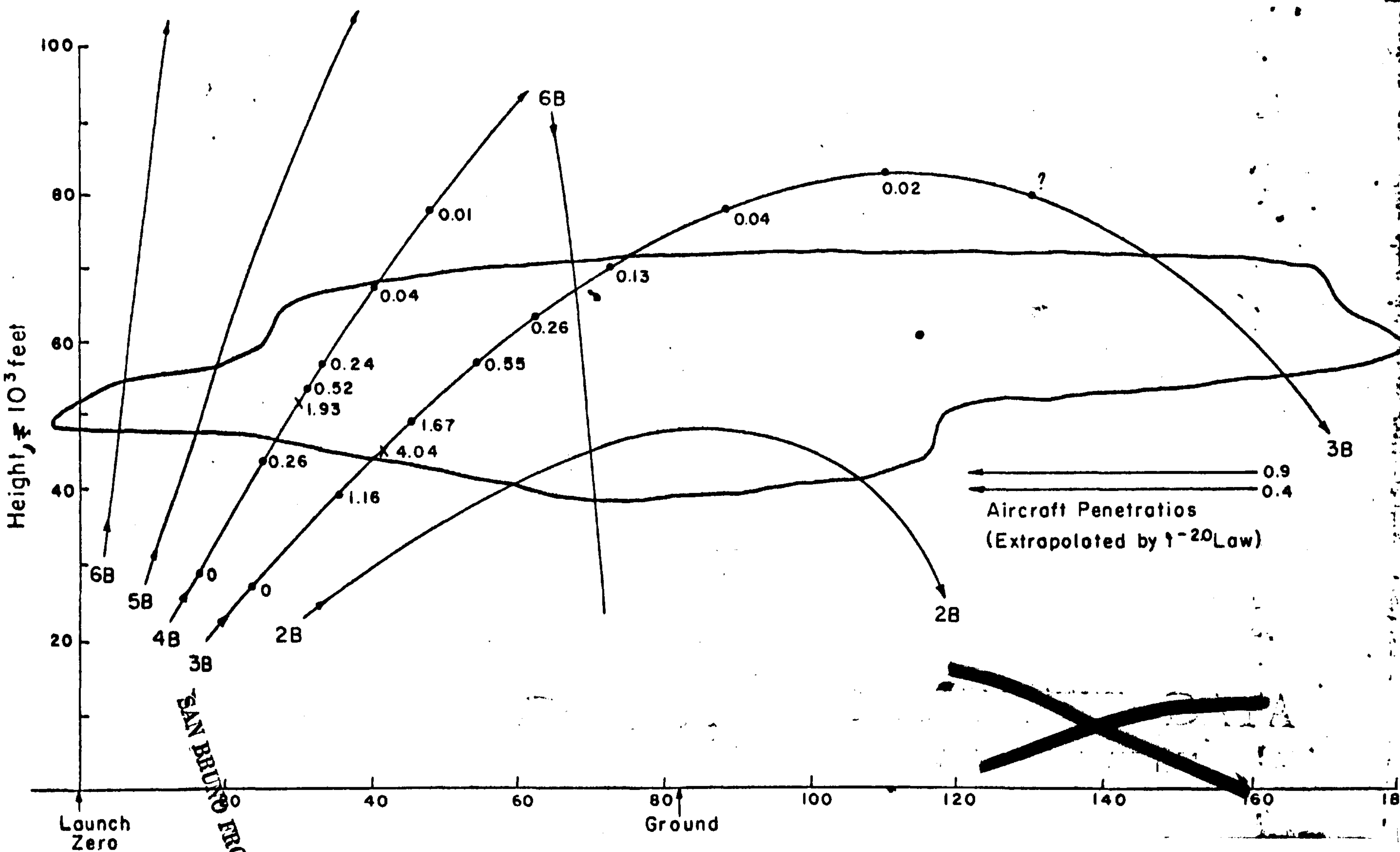

Figure 3.27 Cherokee Cloud at H+15 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted with an x.

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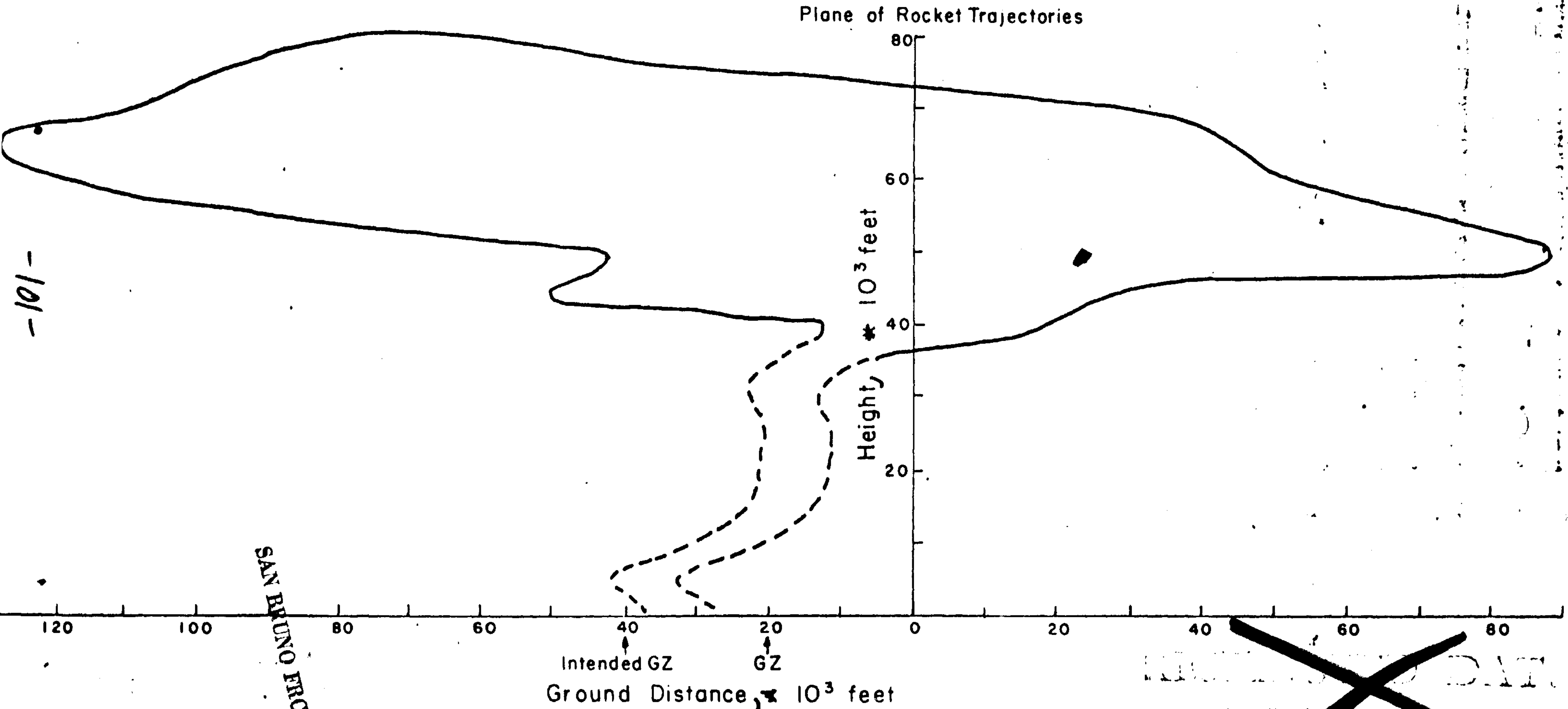

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Figure 3.28 Looking Along Plane of the H/15 Minute Rockets Toward Cherokee Cloud.

The Project 2.66 aircraft performed some penetrations at approximately H+1 hour into the lower portions of the Cherokee cloud and the readings, extrapolated back to H+15 minutes by using 2 for the decay exponent, are also presented in Figure 3.27. Visual observations from the aircraft indicated that the red-brown color, characteristic of oxides of nitrogen which are usually associated with intense radiation in nuclear clouds, was present above the flight altitudes. Therefore, the radiation fields detected by the aircraft were undoubtedly much smaller than those present at higher altitudes.

3.2.1.3 Particle Fall Plot. Figure 3.29 represents the particle fall plot for the winds measured at shot time at Bikini Atoll for the Cherokee event. No space and time variations of the wind profile have been included in this plot for two reasons; (1) the variations were not large, and (2) no appreciable fallout was experienced, so detailed correlation with position in the cloud could not be achieved. The interpretation of such a particle fall plot has been summarized in Section 3.1.1.3.

3.2.1.4 Distribution of Fallout. Figure 3.30 portrays the paths followed by the surface vessels and the aircraft through the predicted fallout area during the Cherokee fallout survey. The survey readings were essentially background levels throughout the survey. The upper limit of the land equivalent exposure rate readings in the surveyed area was less than 0.5 r/hr when extrapolated to H+1 hour by a $t^{-1.0}$ decay equation. A comparison of Figure 3.30 with Figure 3.29 indicates that it is unlikely that any major fallout areas were missed by the survey vehicles and therefore it is clear that this particular type of event

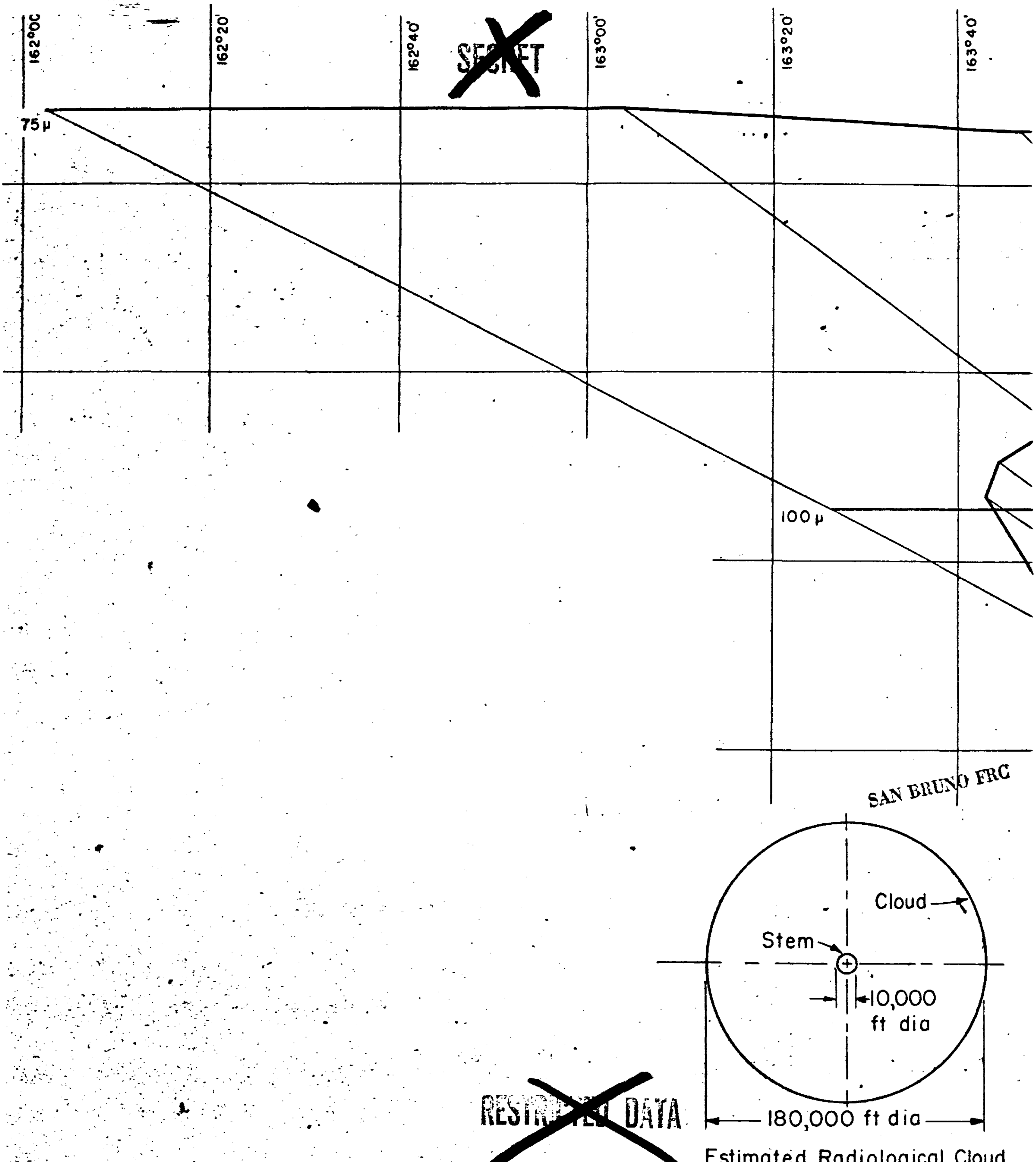
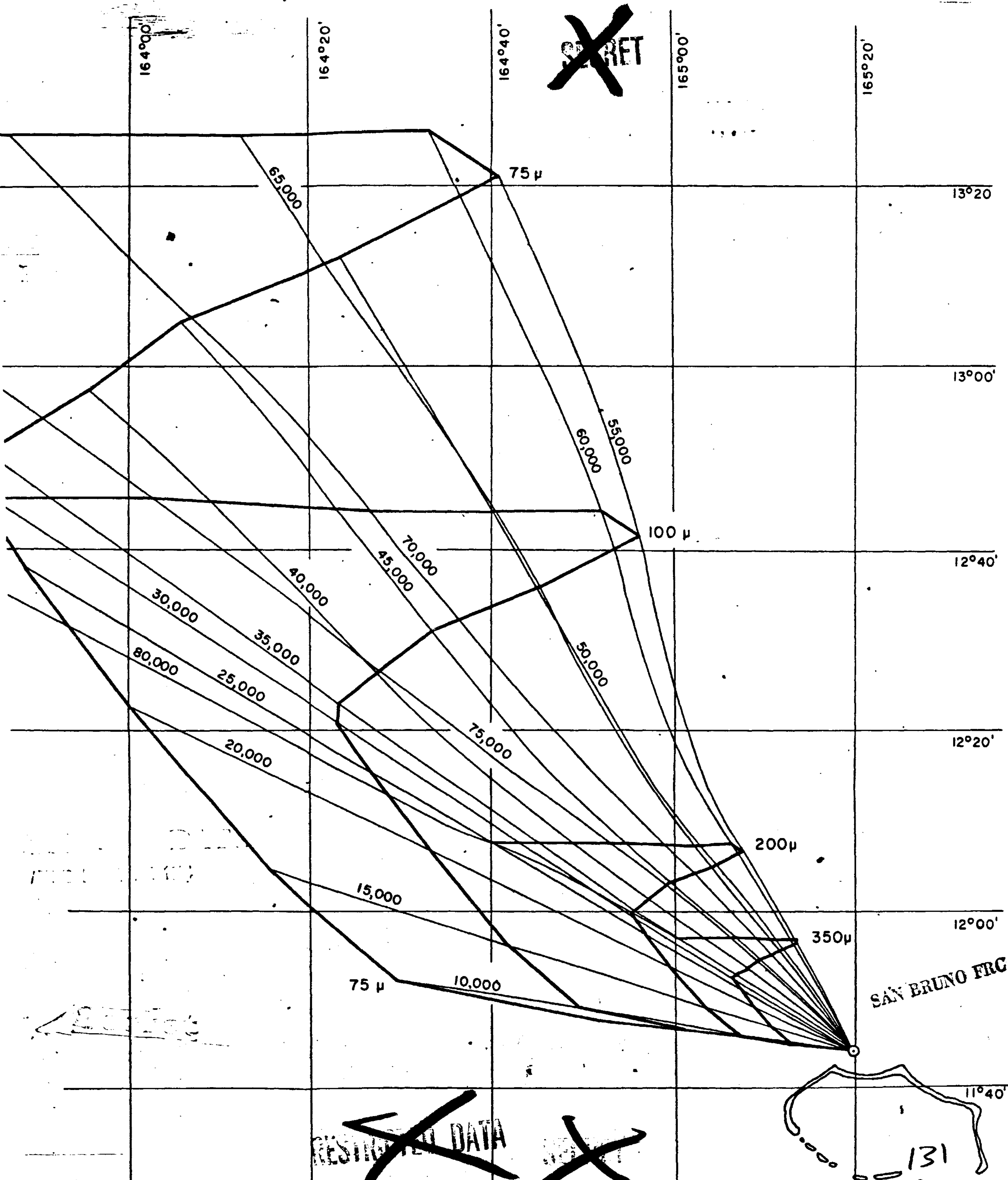


Figure 3.29 Cherokee Particle Fall Plot



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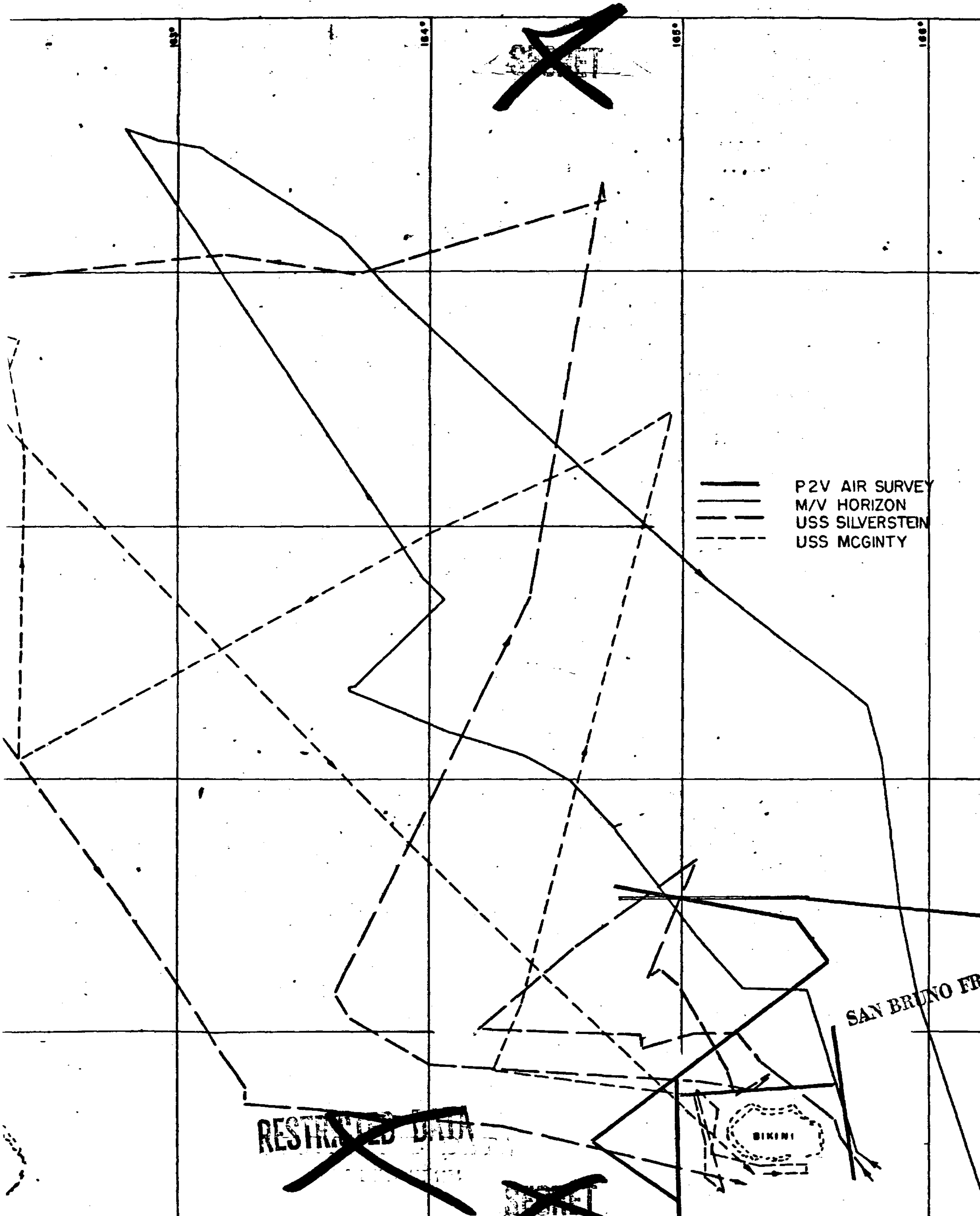

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Figure 3.30 Ship and Aircraft Paths for Cherokee Fallout Survey.

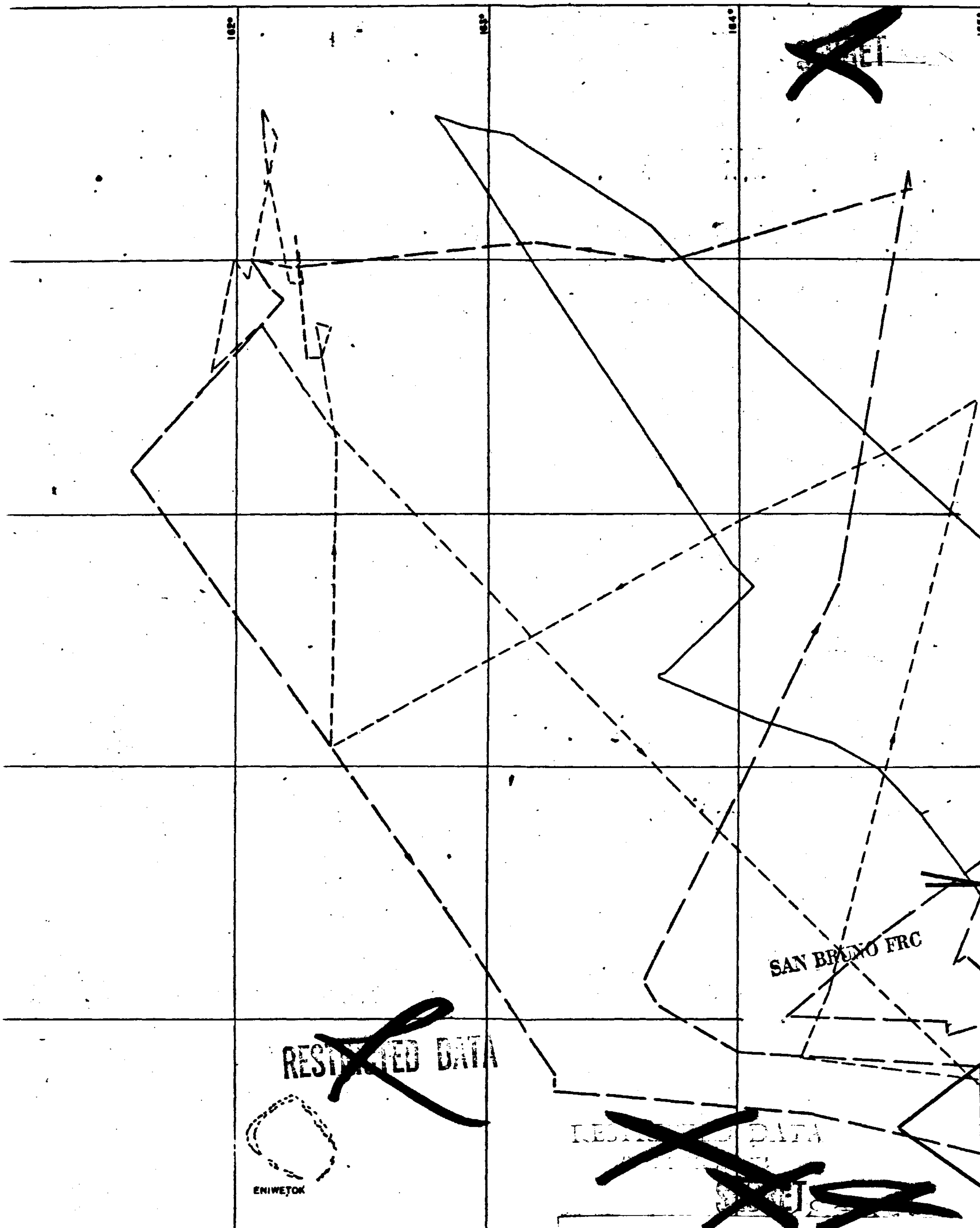
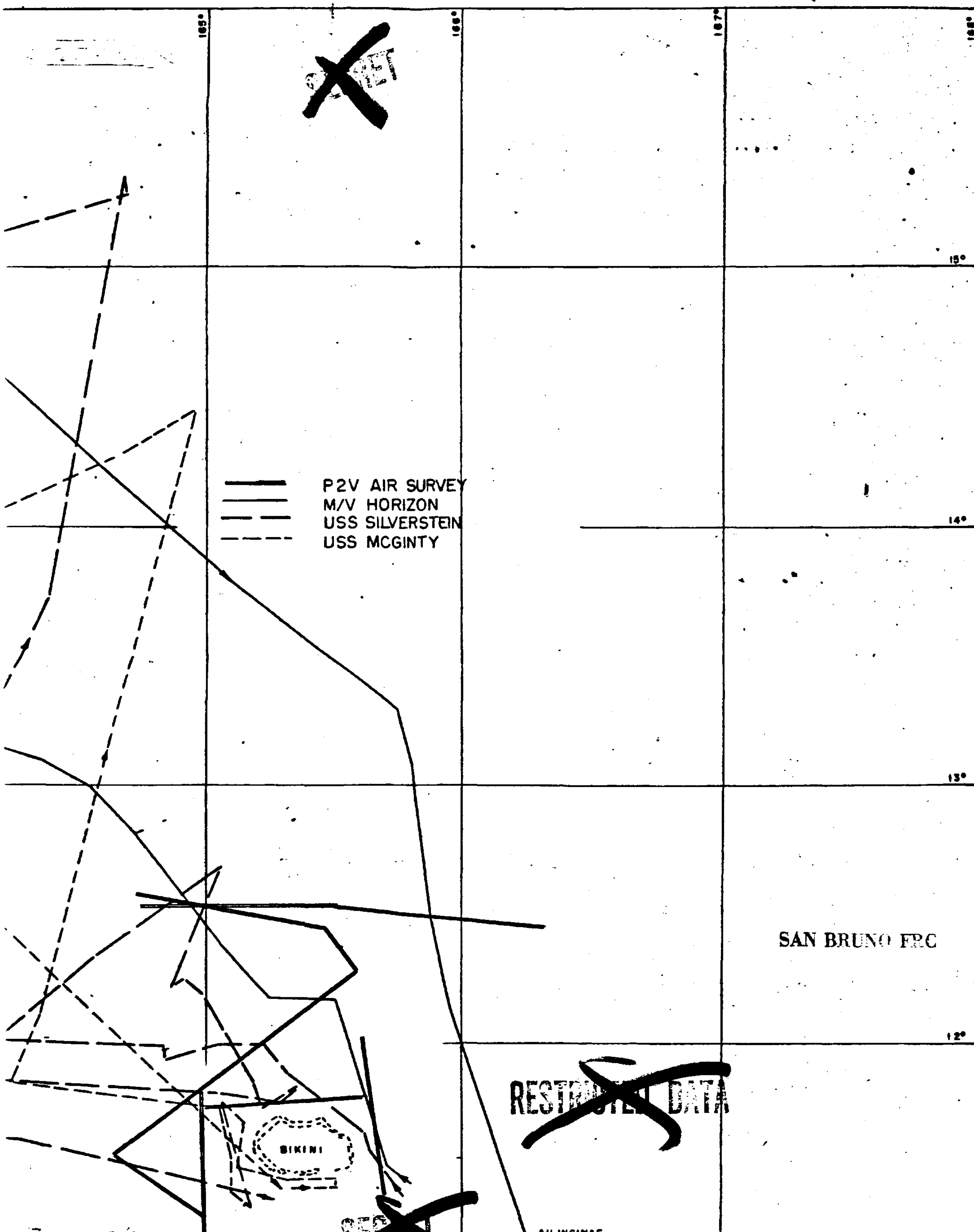


Figure 3.30 Ship and Aircraft Paths for Cherokee Fallout !



'aths for Cherokee Fallout Survey.

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does not produce an appreciable density of fallout contamination.

3.2.2 Osage. The Osage device was detonated at a height of 630 feet over Site Yvonne at 1314M on 16 June 1956. The yield was measured to be [redacted] The only available data on radiation levels is from RadSafe surveys since no Program 2 fallout projects participated. The H/1 hour exposure rate at ground zero was measured to be about 16 r/hr. All other measurements could not be distinguished from the residual radiation from previous detonations.

3.3 WATER SURFACE BURSTS

3.3.1 Flathead.

3.3.1.1 Introduction. The Flathead Shot was fired on a barge located off Site Dog (see Figure 3.31) at 0626M on 12 June 1956. The yield was measured to be [redacted] The only large masses of material in the shot barge were steel (about 260 tons) and coral (about 230 tons). It would not be surprising if a small but measurable amount of these materials was found in the fallout collectors since a calculation assuming that there is no fractionation, namely that the fission product activity is proportional to the total mass of barge material deposited, predicts that about 3 mg each of iron and coral should be deposited per square foot of surface at a location where the exposure rate extrapolated to H/1 hour is 100 r/hr.

As shown in Figure 3.31, the Flathead Shot barge was anchored in approximately 114 feet of water. Therefore, the shot actually approximated a surface water burst in a deep harbor. In addition to furnishing fallout data on these particular shot conditions, it is to be hoped that

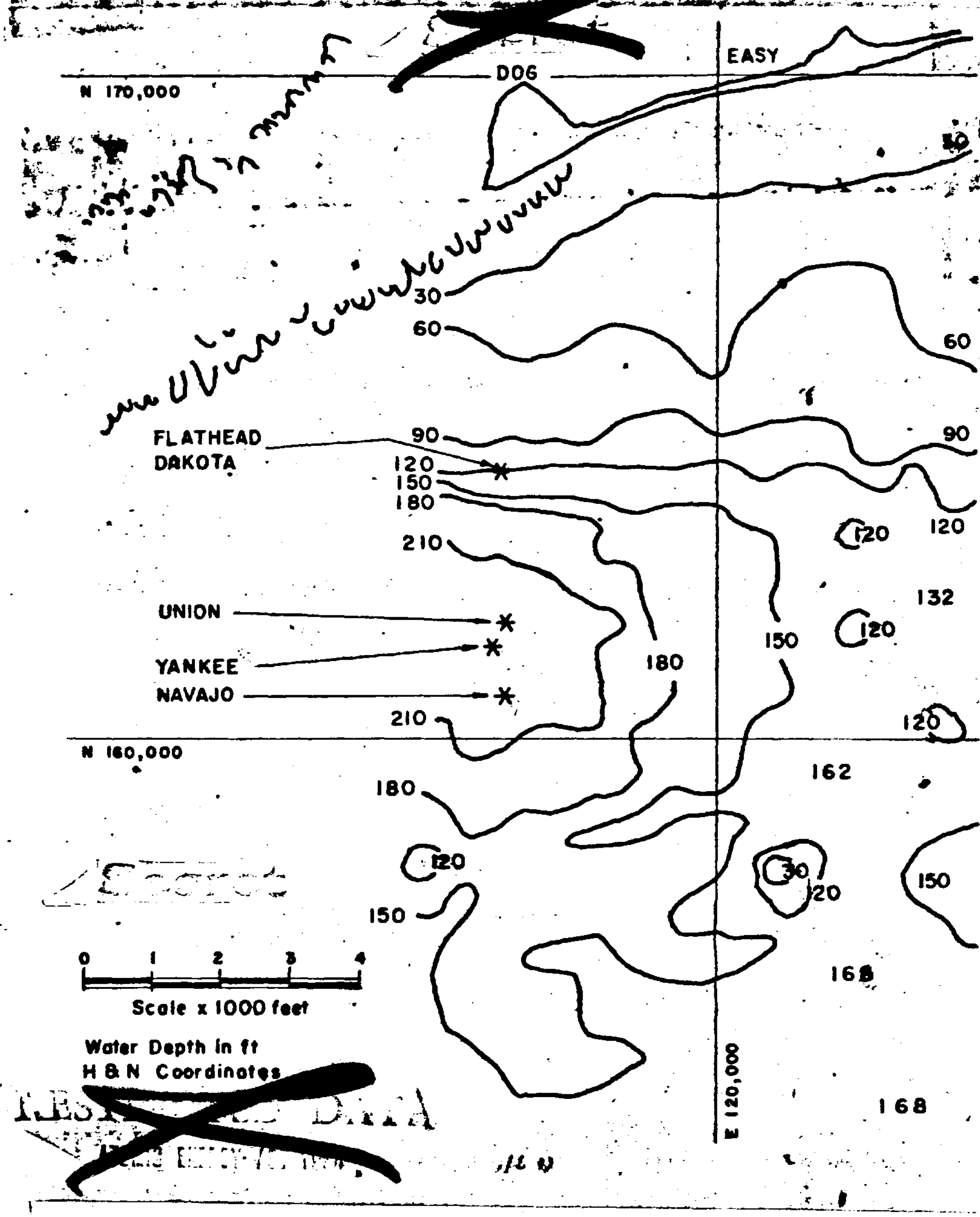

Figure 3.31 Bikini Lagoon Water Depths Prior to REDWING in the Primary Barge Shot Location.

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a more complete understanding of the mechanisms involved can be gleaned from the data so that it can be applied to other burst conditions.

3.3.1.2 Particle Fall Plot. The Flathead particle fall plot is illustrated in Figure 3.32. The unusual appearance of the upper height lines, which come back toward ground zero for the smaller particles, is a reflection of the severe time changes of the wind profile. The fallout times were characterized by a rapidly changing wind situation during which cyclonic or anticyclonic centers moved through the fallout area at most altitudes.

For a review of the limitations and the interpretation of this plot, the discussion in Section 3.1.1.3 should be consulted.

3.3.1.3 Characterization of Fallout Material. The fallout material differed in appearance greatly from that of the land surface bursts. At the close-in stations, most of the activity was associated with a "mud." This material was collected with difficulty, remained quite wet for a period of a day, and was subsequently removed from the collecting surfaces with even more difficulty. It was found to consist of fine coral particles, NaCl, and sizeable amounts of FeO_3.

The more distant fallout consisted mainly of a salty slurry. The effective droplet diameter at the YAG 40 position was 100-200 microns, and these consisted of 80-90 percent NaCl. The activity was, in general, associated with a very small (5-10 micron) particle inside the droplet.

3.3.1.4 Land Equivalent Distribution of Fallout Activity. The data for the fallout radiation plot of Figure 3.33 have been derived from the same sources as those enumerated in Section 3.1.1.5. However, the fact

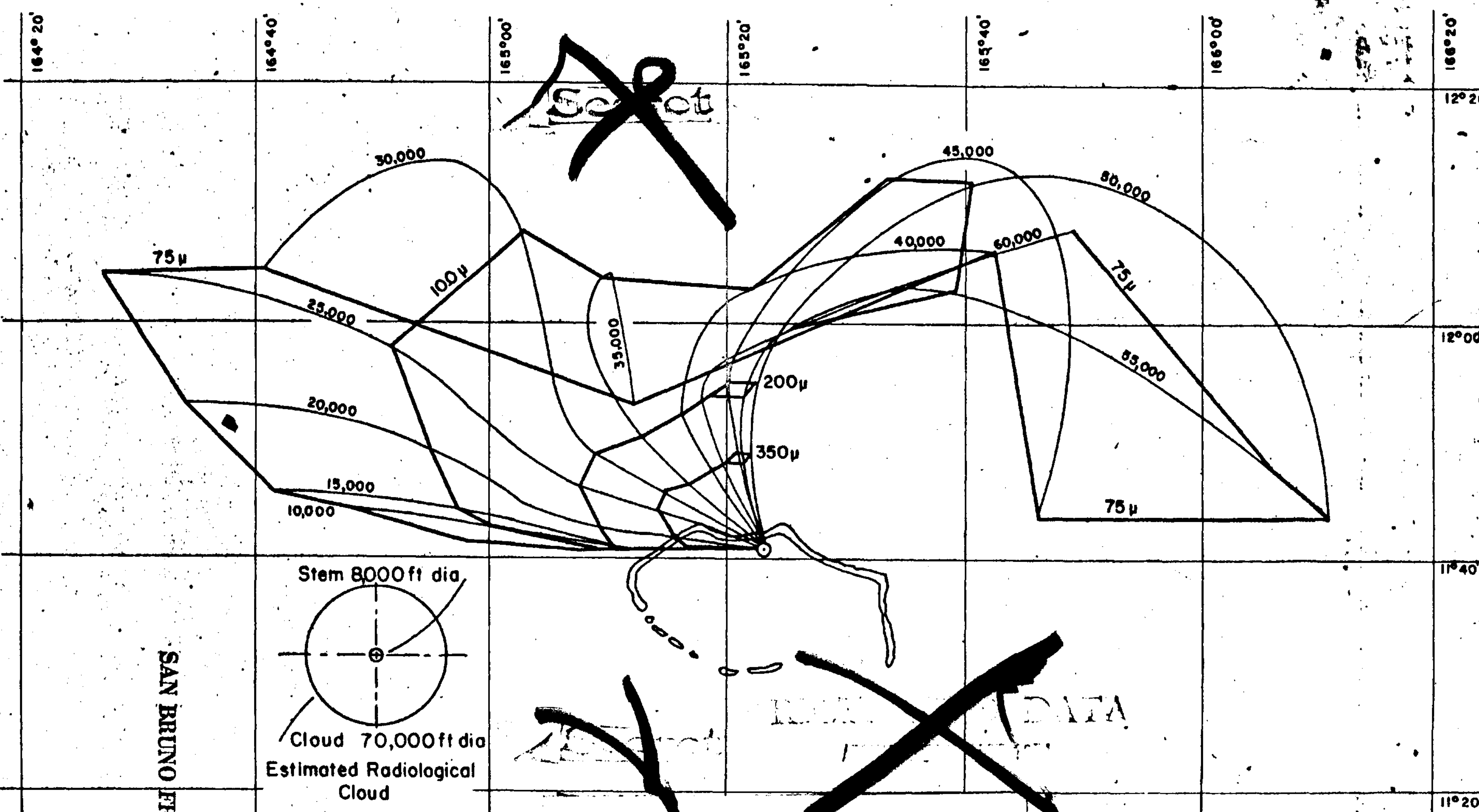

Figure 3.32 Flathead Particle Fall Plot.

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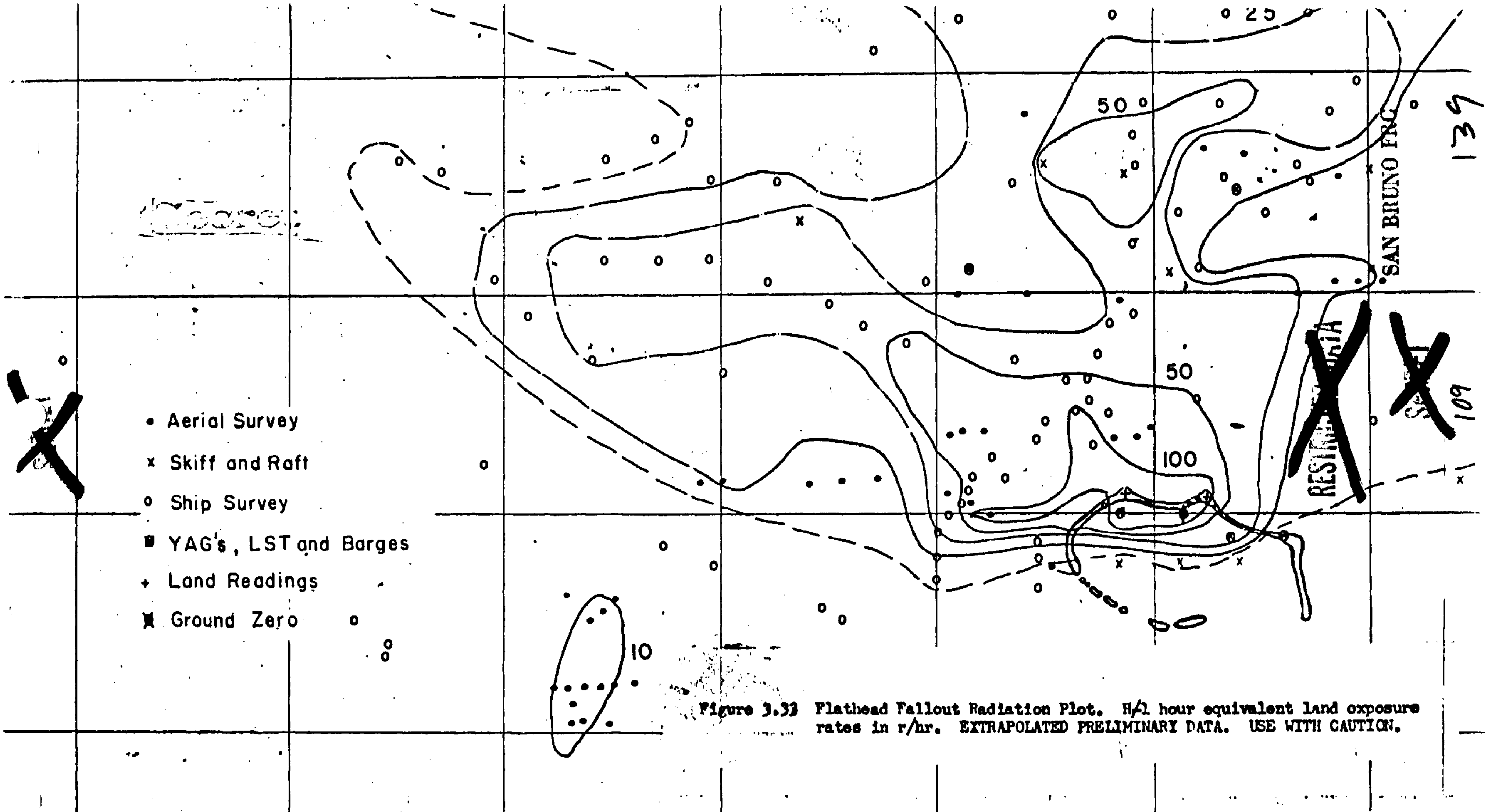

Figure 3.33 Flathead Fallout Radiation Plot. H/1 hour equivalent land exposure rates in r/hr. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

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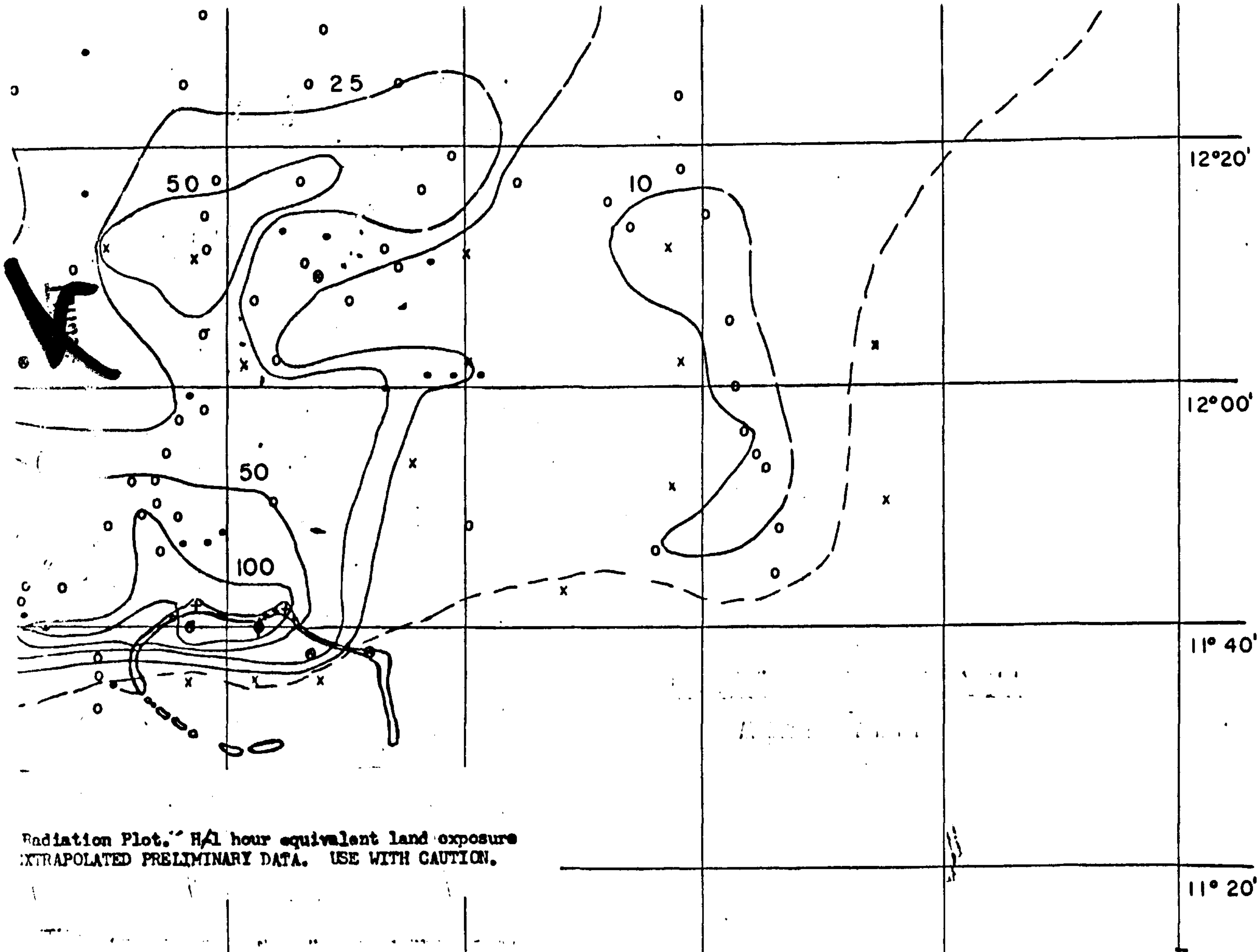

Radiation Plot. H/1 hour equivalent land exposure
EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

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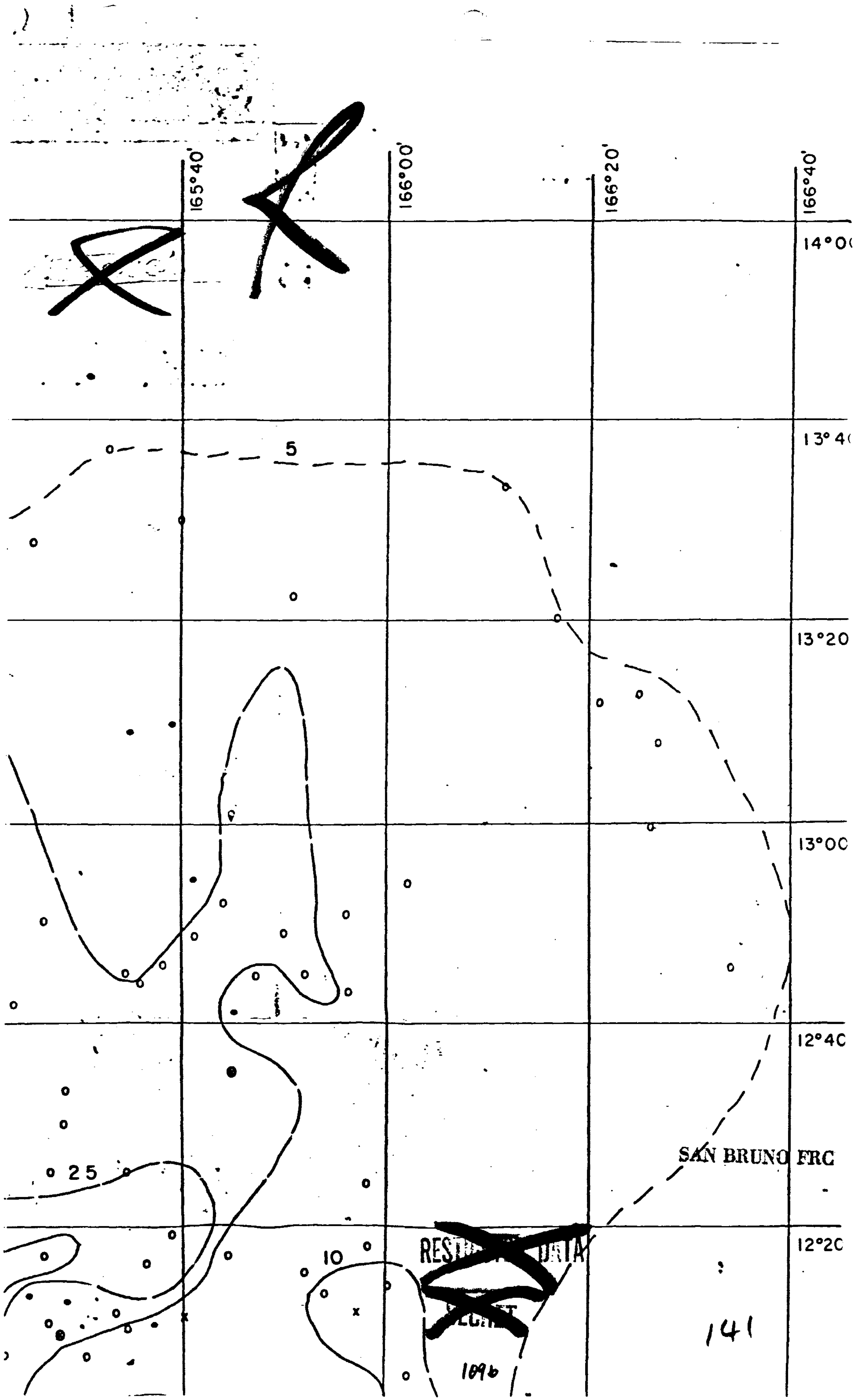
165°40'
166°00'
166°20'
166°40'
14°00
13°40
13°20
13°00
12°40
12°20
5
25
10
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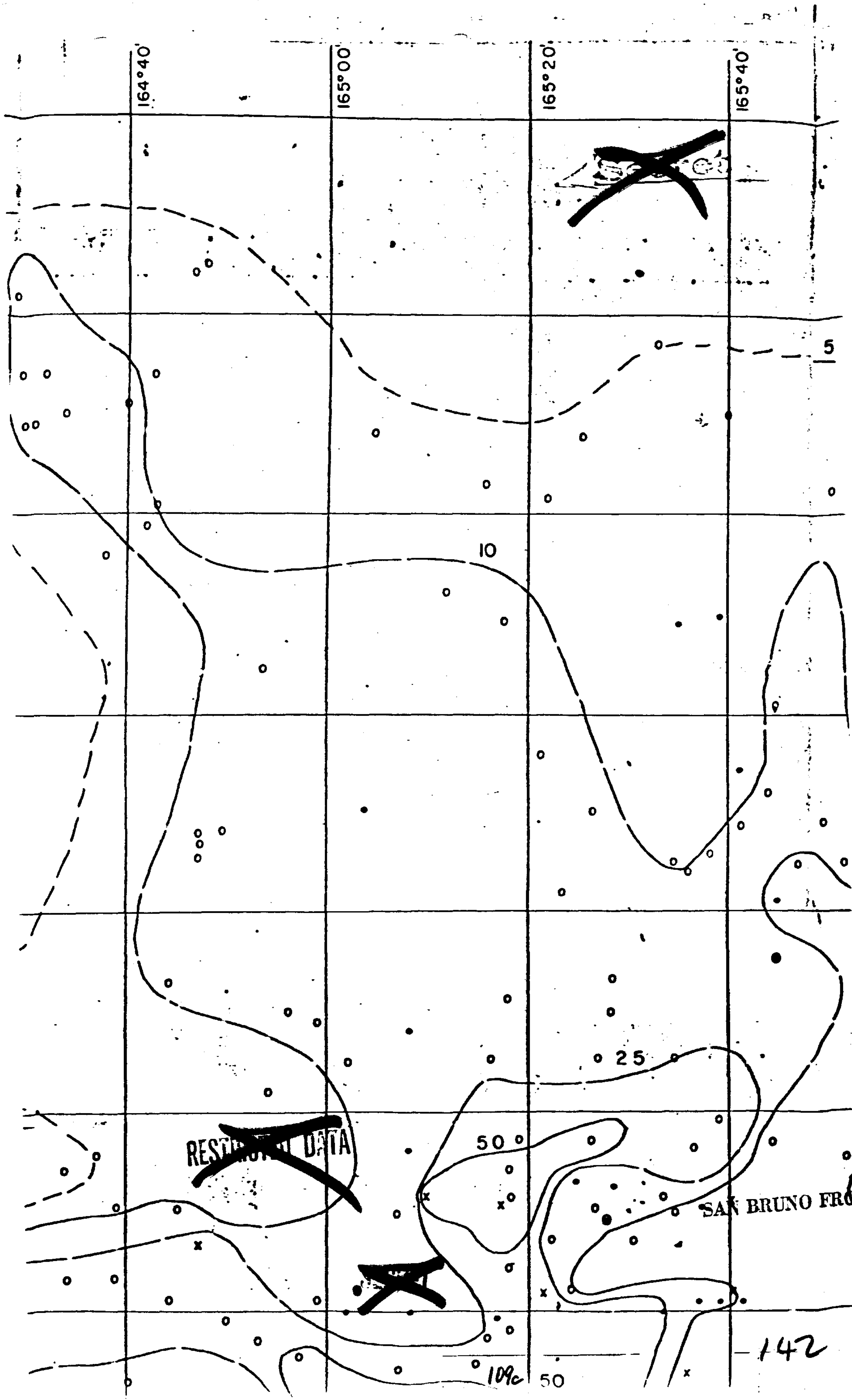
DATA
1096
141


164°40'
165°00'
165°20'
165°40'
5
10
25
50
50
109c
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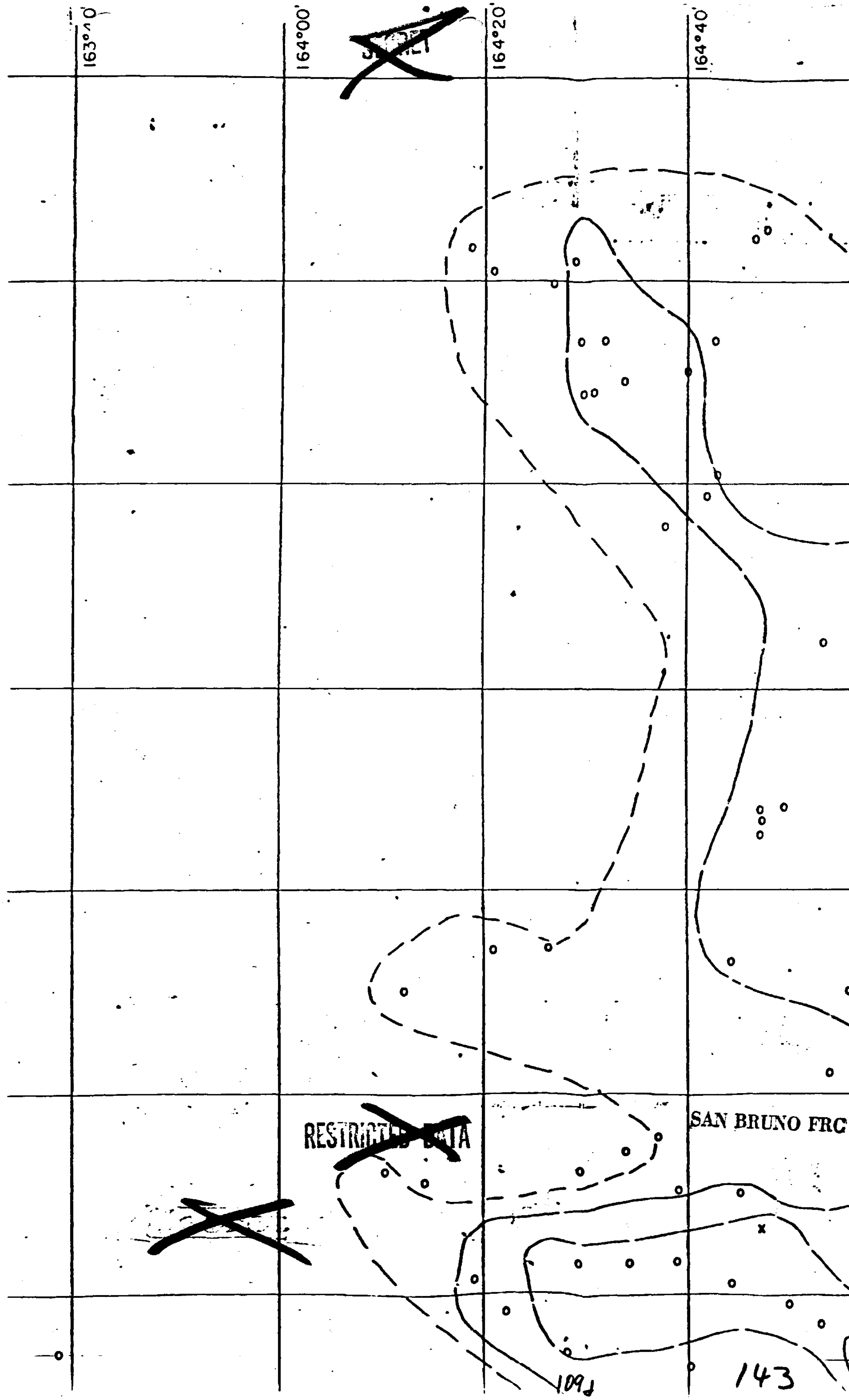
142



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that the activity from this water surface burst was generally associated with liquid or very small particulate enclosed by liquid droplets implies that the water survey readings can be used with more confidence. In this case, most of the activity would be distributed in depth by the mixing of the ocean water and not by the direct influence of gravity on particulate matter. Since there probably was no activity associated with sizeable solid particles, ~~therefore all the activity that was deposited on the~~ ocean surface was accessible to the probe readings. An example of the readings on a typical probe cast is illustrated in Figure 3.34.

The problem of background radiation levels can not be considered in this report. Suffice it to say that low background readings extrapolated for assumed decay during the long periods of the survey, can have appreciable influence on the measured contour values. The data as presently reduced have not been corrected for such effects. An illustration of this problem is furnished by a survey that was performed subsequent to the Flathead event, but just prior to Navajo. It indicated that a region west of Bikini Atoll and curving toward the south was contaminated by water which probably originated near the Zuni and Flathead craters (see Figure 3.43). It is therefore quite likely that the finger-like region of contamination indicated in this area by the Flathead fallout surveys was not caused by fallout, but was due to contaminated effluent from the Bikini Lagoon.

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The observations by Project 2.62 probe casts, which measured vertical radiation profiles similar to that illustrated in Figure 3.34, ~~were~~ indicated that the effective depth of penetration for the Flathead fallout was about

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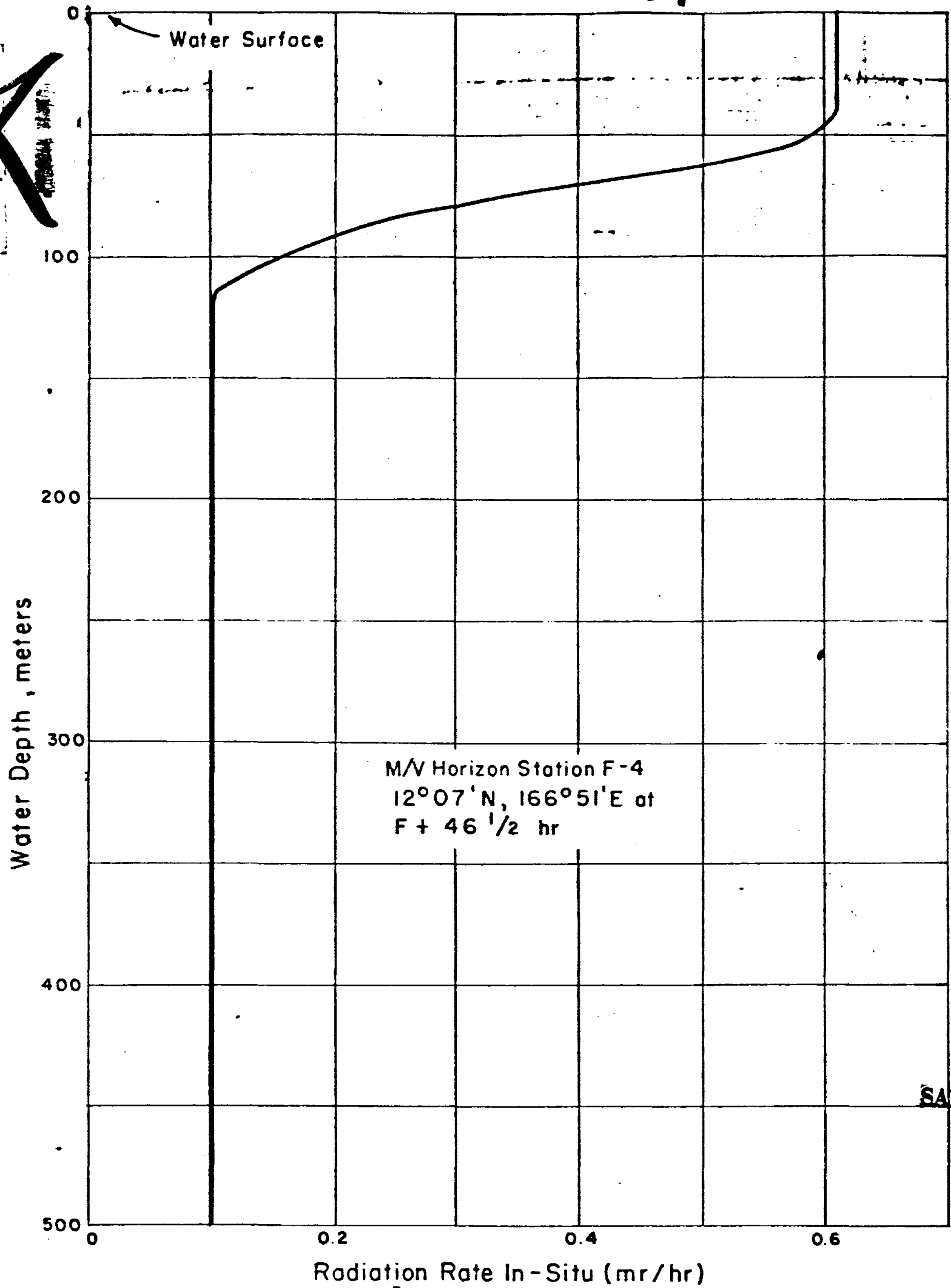

Fig 3.34

Figure 3.34 Typical Exposure Rate versus Depth Profile. This was r[illegible] northeast of Flathead ground zero at 0430 on 14 June 19[illegible]

111

36 meters at 10 hours after the detonation, increased linearly to 80 meters at 34 hours, and thenceforth remained essentially constant. The decay exponent measured by the probe in the decay tank aboard the M/V Horizon was ~~1.13~~ 1.05. These observed values of the depth of penetration and decay exponent were used in the reduction of the Project 2.62 water survey and Project 2.64 aerial survey data. The water motion corrections discussed in Section 3.1.1.5 were also applied to this data.

3.3.1.5 Central Time of Arrival Contours. The calculated central time of arrival contours, as well as the observed data points, are presented in Figure 3.35. The interpretation of this data has been discussed in Section 3.1.1.6.

3.3.1.6 Ten Hour Exposure Contours. The ten hour exposure contours for Flathead constructed as discussed in Section 3.1.1.7 are presented in Figure 3.36. The corrected exposure data points are also indicated in this figure.

3.3.1.7 Cross Decay ~~Curves~~ Exponent. The Np^{239} capture to fission ratio reported for the Flathead event was 0.31. The decay exponents measured under various conditions are summarized in Table 3.4.

3.3.2 Navajo.

3.3.2.1 Introduction. The Navajo device was fired on a barge moored off Site Dog (Figure 3.31) in water about 215 feet deep, at 0556M on 11 July 1956. The yield of the weapon was measured to be [redacted]
[redacted] This device was the [redacted] of the REDWING devices and therefore provided an excellent opportunity to document the fallout fairly near the shot point without exposing the

Figure 3.35 Flathead Central Time of Arrival Plot. Times in hours.

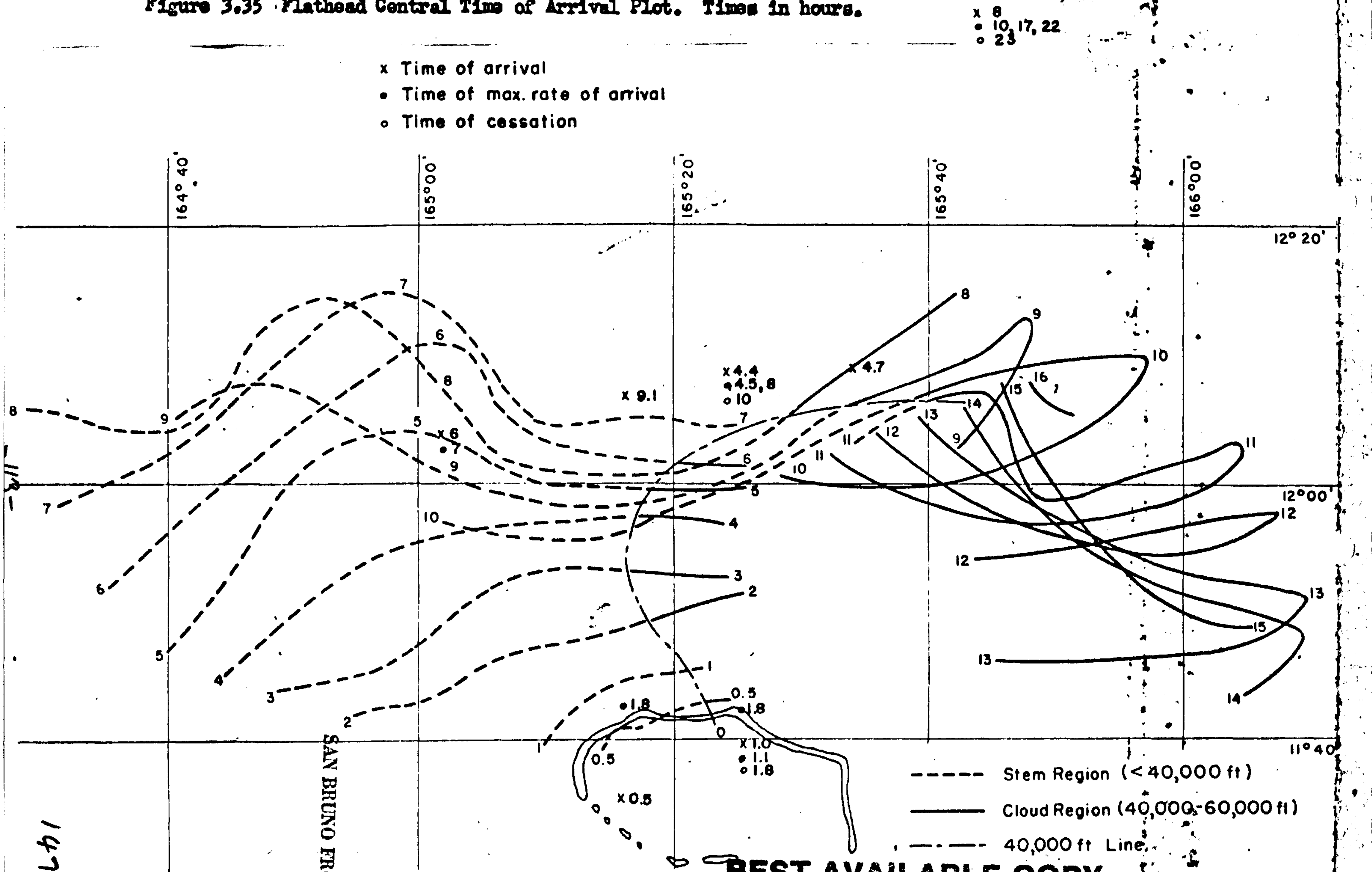

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Fig. 3.35

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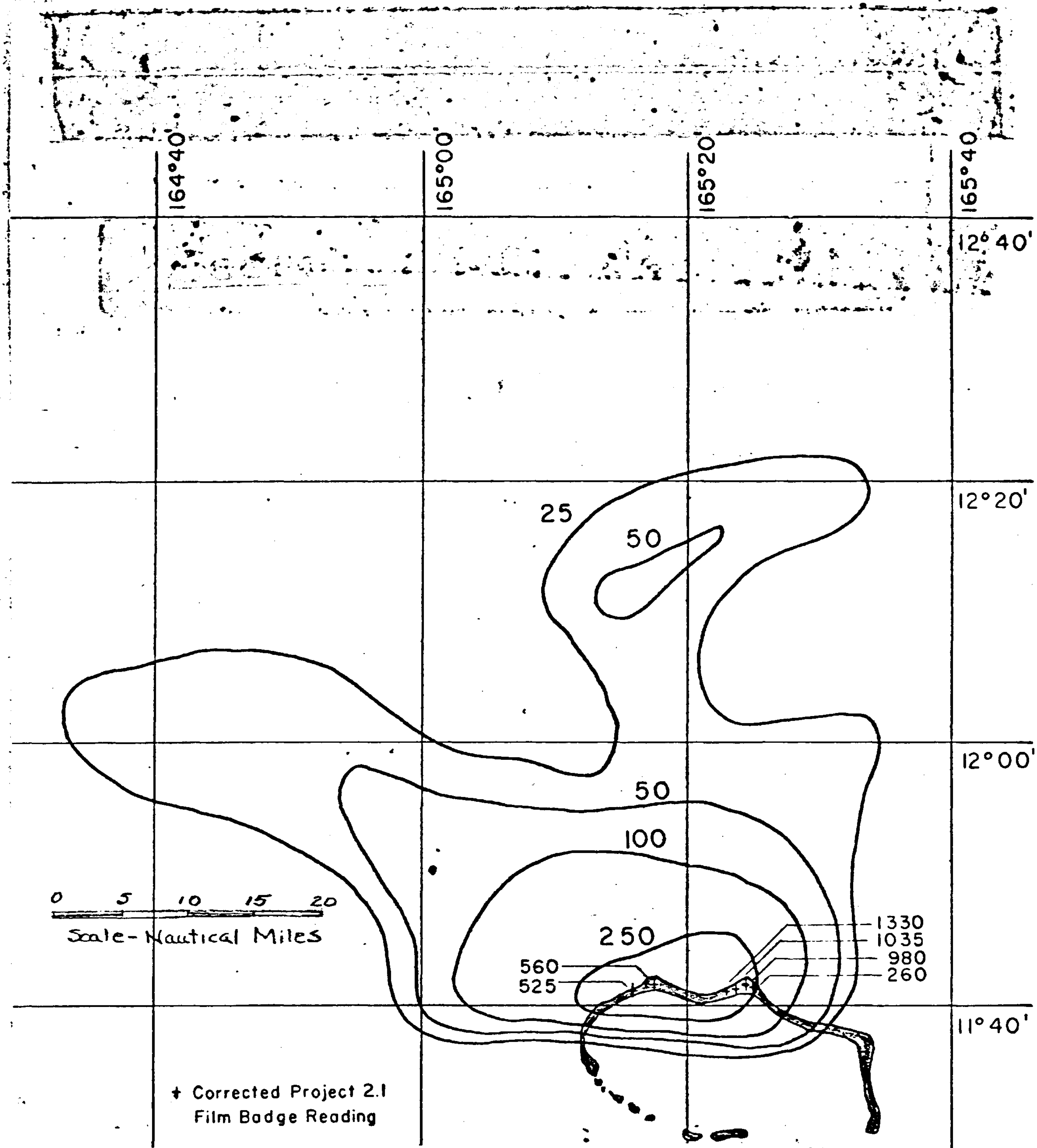

Figure 3.36 Flathead Ten Hour Exposure Contours.
Exposure in r. EXTRAPOLATED PRELIMINARY DATA USE WITH CAUTION

11°20'

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TABLE 3.4 Cross Decay Exponents for Flathead

	Time (Hours)	5–20	20–50	50–200
Decay Exponent	Gamma Photons*	–	0.6	1.0
	Gamma Exposure Rate	–	1.2	1.2
	Beta dis/min	–	0.9	1.0
	Field Gamma Exposure Rate	–	1.0	–
	Gamma Exposure Rate in Water	–	~~1.13~~ 1.05	–

*YAG-40 Samples Only

[redacted]

operational personnel to excessive radiation.

To compare radiation readings from Navajo with those DELETED

DELETED

The wind profile ~~pattern~~ which existed at and after shot time was characterized by very weak winds at all altitudes up to 55,000 feet, and hence much of the fallout pattern was concentrated quite close to Bikini Atoll. Nevertheless, the observed radiation exposure rate ~~intensities~~ were not excessive. However, if the Navajo weapon's yield had been predominantly from fission reactions, the exposure rates in the Dog-George complex would have been higher than 1000 r/hr at H+1 hour and operational difficulties would have resulted for all agencies needing access to those sites.

The Navajo detonation ~~device~~ also provided the opportunity to measure the effectiveness of "salting" by a tracer experiment. About [redacted] each of [redacted] DELETED DELETED [redacted] were inserted amidst the thermonuclear fuel and the collected fallout material was analyzed for the activation products resulting from neutron capture reactions. However, this detailed radiochemical analysis was performed in the home laboratories of Projects 2.63 and 2.65 and therefore the results were not available at the time of writing of this report.

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The contribution to the fallout radiation from activity induced in the surrounding material of the shot point could also be determined.

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DELETED the chance of detecting induced activity in the presence of the fission product activity was increased. In particular, activity from Na^{24} produced in the salt water was expected to be observed even though

[redacted]

...s half life is only 15 hours. Again this analysis was performed in the home laboratories and the results were not available for this report.

The Navajo shot barge included about 250 tons of iron and 200 tons of coral, but this material was spread over a much larger area by the [redacted] DELETED [redacted] compared with Flathead. Since [redacted] DELETED [redacted] DELETED the association of exposure rate and mass of material is the same (i.e., about 3 mg each of iron and coral per square foot where H/1 exposure rate is 100 r/hr), but the levels of the radiation fields from Navajo were much lower than those from Flathead.

3.3.2.2 Distribution of Activity in the Stabilized Cloud and Stem. Since the previous shots, Cherokee and Zuni, had yielded reasonably good data on the distribution of activity in the nuclear cloud, but no data on the stem, it was decided to allocate the entire six rockets of the H/7 minute salvo to the Navajo stem. The rockets were all aimed at an elevation corresponding to a penetration height of about 26,000 feet and were spread in azimuth to cover all possible directions of motion of the stem to be expected from the local wind conditions.

Figure 3.37 presents the cross sections of the stem in the plane of the trajectories of rockets 2A, 3A, and 4A. Figure 3.38 is a view of the stem looking along the trajectories indicating the points at which the rockets pierced the center plane of the stem at 26,000 feet. Only two of the rockets indicated radiation; Numbers 2A and 3A. These exposure rates were less than 50 r/hr, and could not be accurately measured with the equipment available in the field. Rocket 2A received a total exposure of about 0.08 r between 13 and 28 seconds after launch time, and rocket 3A received a total exposure of about 0.24 r between 11 and 41 seconds

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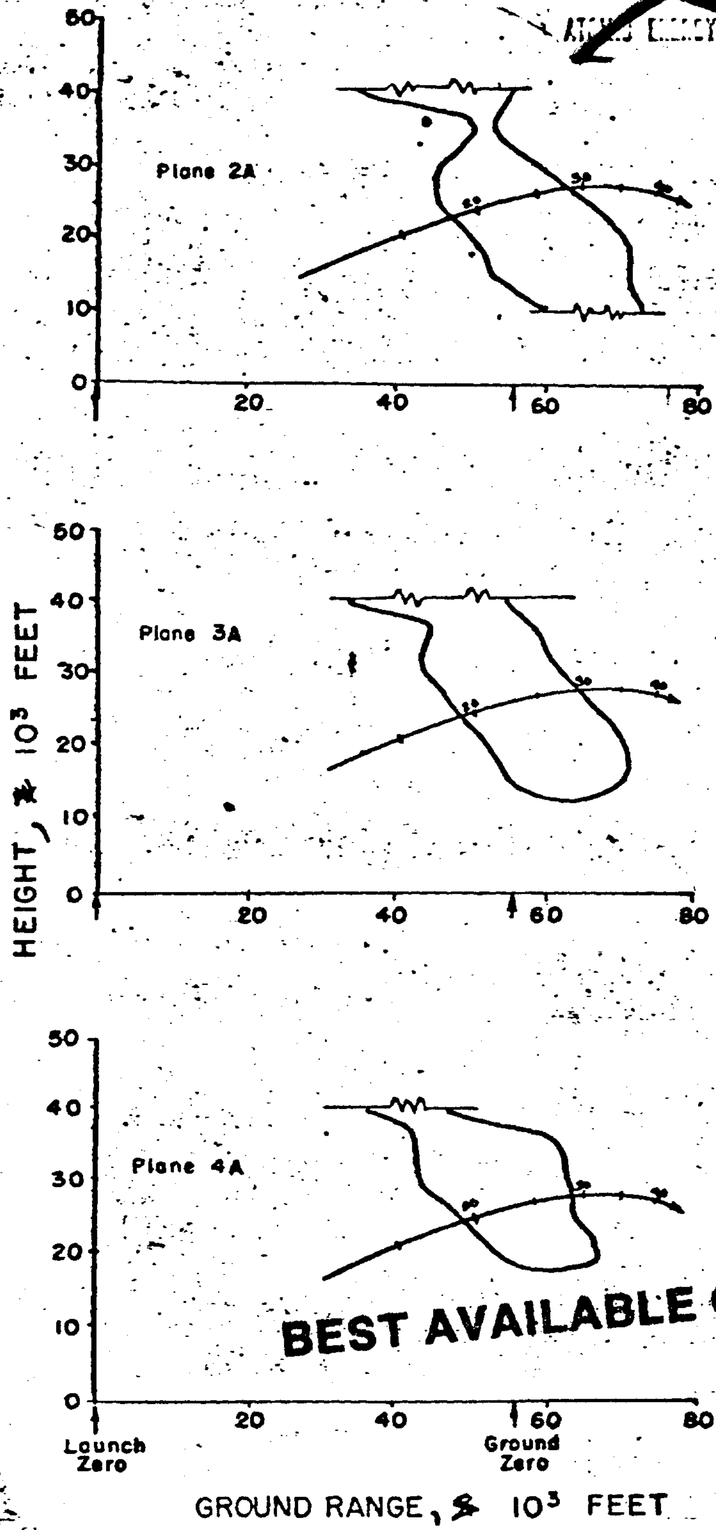

Figure 3.37 Navajo Stem at H+7 Minutes Showing Planes Through Three Rocket Trajectories. Numbers along trajectories are time in seconds from launch time.

...ter launch time. ~~Inspection of the positioning information in Figures 3.37 and 3.38 then~~ Preliminary analysis of the data indicates the following tentative conclusions:

a. The exposure rate in the stem is smaller than that in the cloud by at least a factor of 40.

b. The position of the stem checks with that predicted assuming the wind displaces it from zero time.

c. The radiological diameter of the stem is no larger than the visual diameter, and the indications are that the largest exposure rates are limited to a small fraction of the stem volume.

The H+15 salvo was allocated to measuring the exposure rate in the nuclear cloud, but in addition was designed to yield data on the reproducibility of the detector readings. Only three trajectories were chosen and two rockets were fired along each trajectory. Comparison of the readings from the one pair of rockets of which both yielded preliminary data indicated that the readings were reproducible within about 20%. The final reduction of the data will probably show the reproducibility to be better than this number.

The data for the three trajectories is presented in Figure 3.39 and the location of the plane of these trajectories through the cloud is illustrated in Figure 3.40.

The Project 2.66 manned aircraft penetrations of the stem of the Navajo mushroom were performed as soon as the Project 2.61 rockets were out of the air. The results of these penetrations, extrapolated back to H+15 minutes using a $t^{-2.0}$ decay relationship, are also presented in Figure 3.39.

The mushroom size which was used in Figures 3.39 and 3.40 was taken from a H+8 minute photograph. While there is some cloud expansion from the time

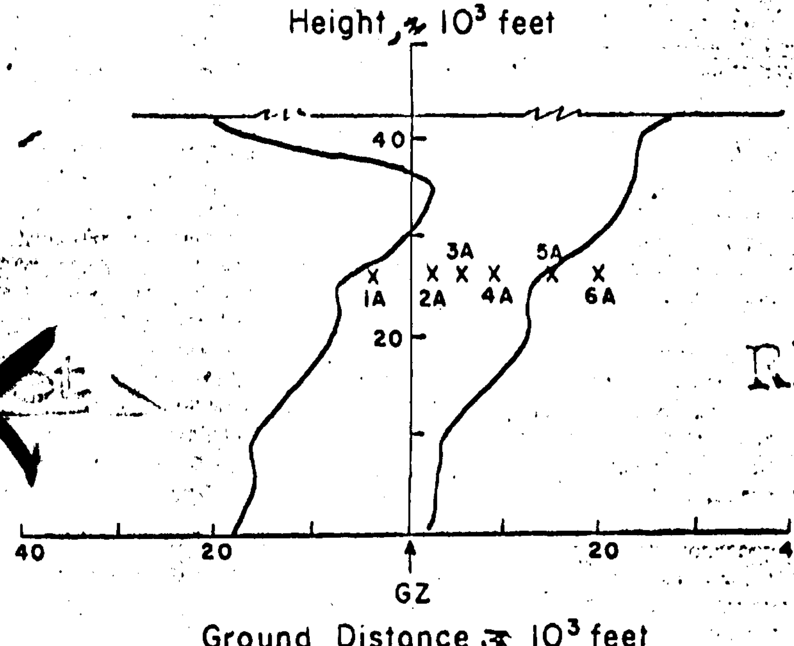

Figure 3.38 Navajo Stem at H+7 Minutes Showing Points (x) at Which Rockets Pierced Center Plane of Stem.

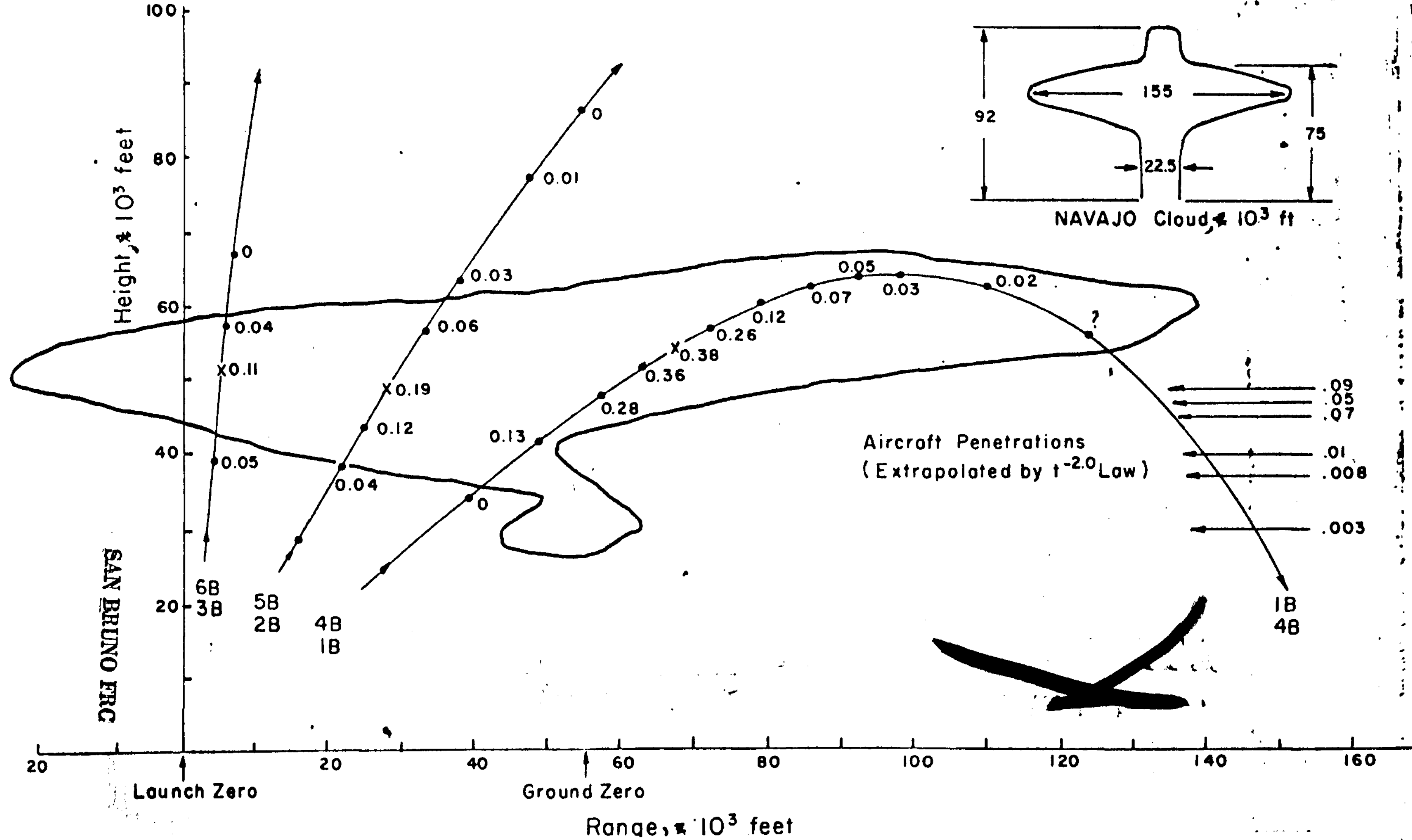

Figure 3.39 Navajo Cloud at H+15 Minutes in the Plane of the Rocket Trajectories. Readings along trajectories are corrected to sea level and are in units of 10^3 r/hr. Peak readings are denoted by an x.

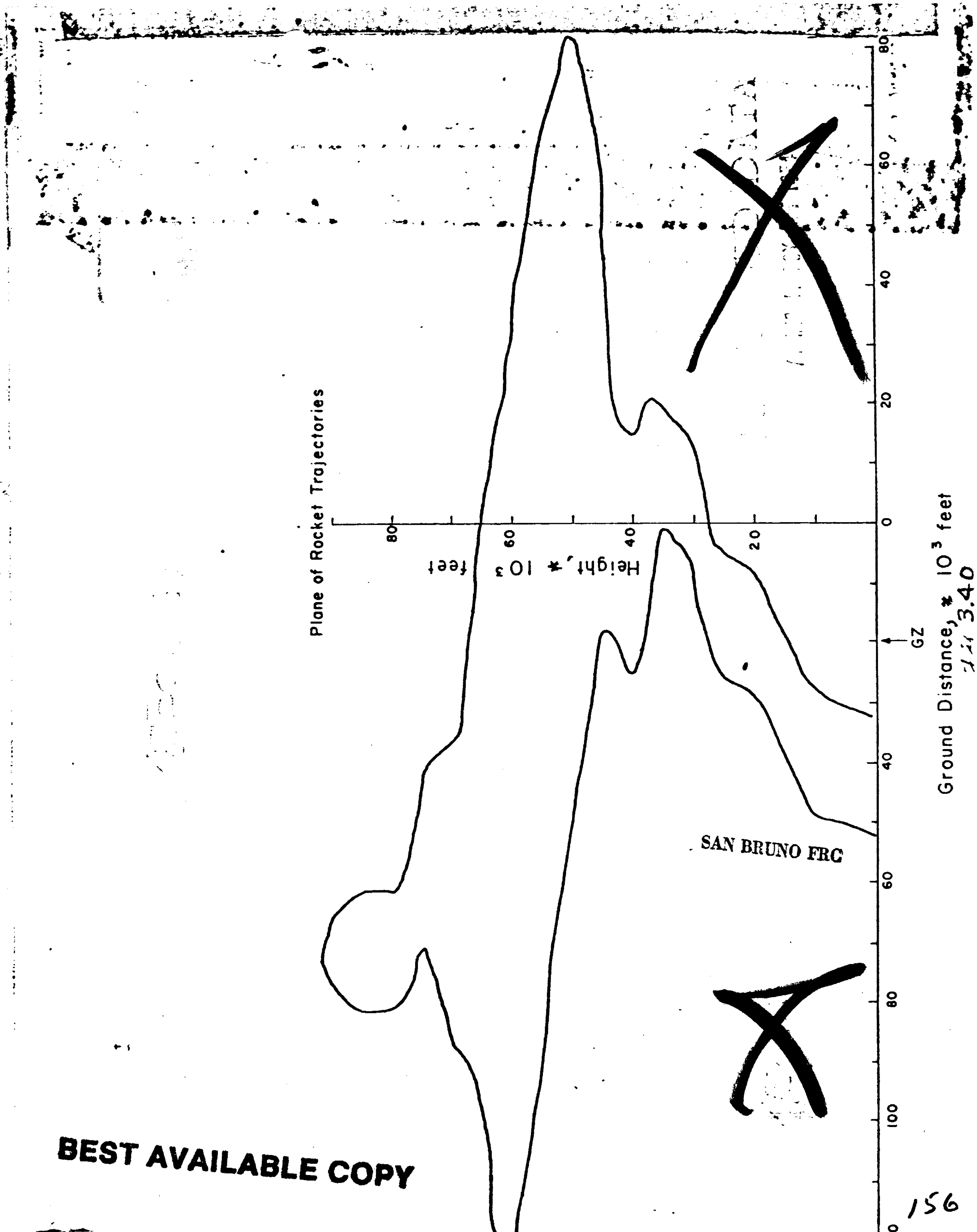

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Figure 3.40 Lo[illegible]ing Along Plane of H/15 Minute Rockets Toward Navajo Cloud.

of the photograph to the time of the second salvo, this will not materially affect the general location of the rocket trajectories relative to the cloud. The fact that the assumed Navajo cloud is slightly smaller than the lower yield Cherokee-Zuni cloud is associated with the different methods used to derive the dimension. This inconsistency must be resolved by more complete analysis of photographic data.

3.3.2.3 Particle Fall Plot. The particle fall plot for the winds measured at and after shot time for the Navajo event is presented in Figure 3.41. This plot, which was constructed considering time and space variations of the wind profile, is characterized by the same weak winds that produced the small Flathead particle fall plot. Of course, the fact that the Navajo cloud was much higher, and hence was influenced more by the high altitude strong easterly winds, caused the actual fallout pattern to extend over a larger area than the Flathead pattern.

For a discussion of the interpretation and limitations of this plot, Section 3.1.1.3 should be consulted.

3.3.2.4 Characterization of Fallout Material. The Navajo close-in fallout material, as well as that observed at the YAG-40, resembled the salt laden slurry observed at the YAG-40 after Flathead. By the time the samples from the land stations were recovered, 80-90% of the particulate was fine salt crystals. There was some $CaCO_3$ among the remaining material. No iron was detected.

3.3.2.5 Land Equivalent Distribution of Fallout ~~Material~~. The consolidated radiation survey data are presented in Figure 3.42. The data have been derived from the same sources, and reduced by the same methods, as those

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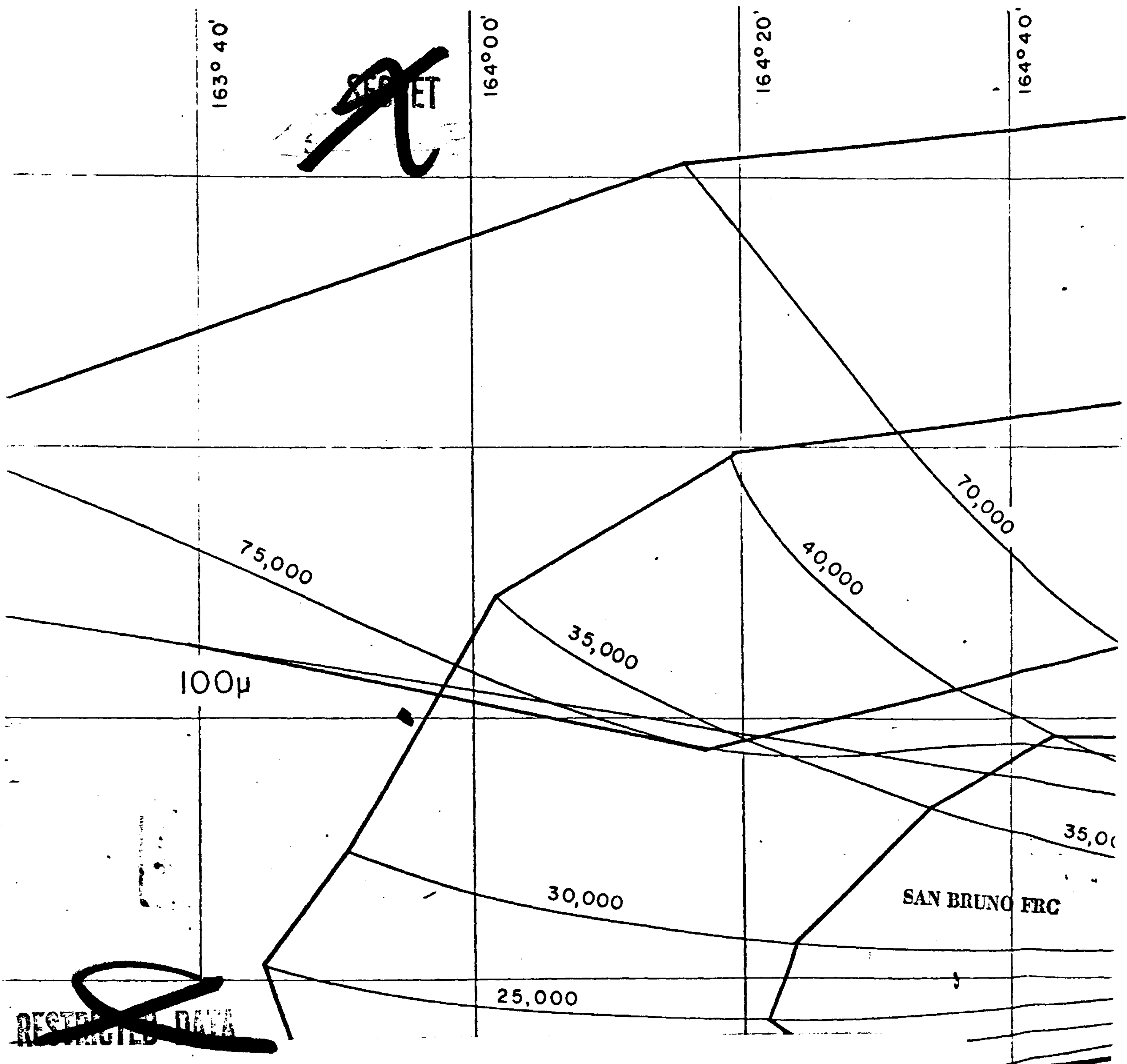

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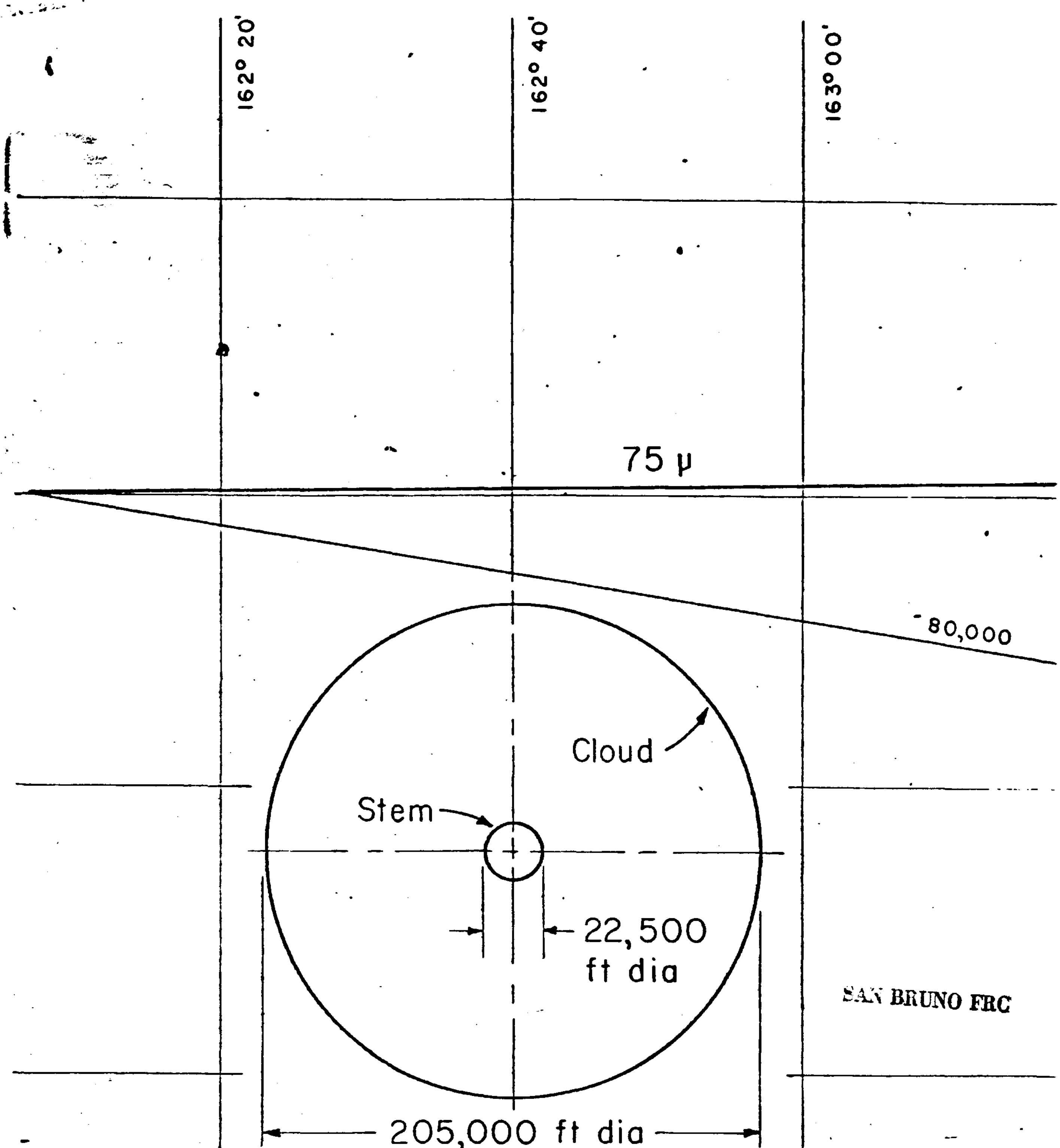
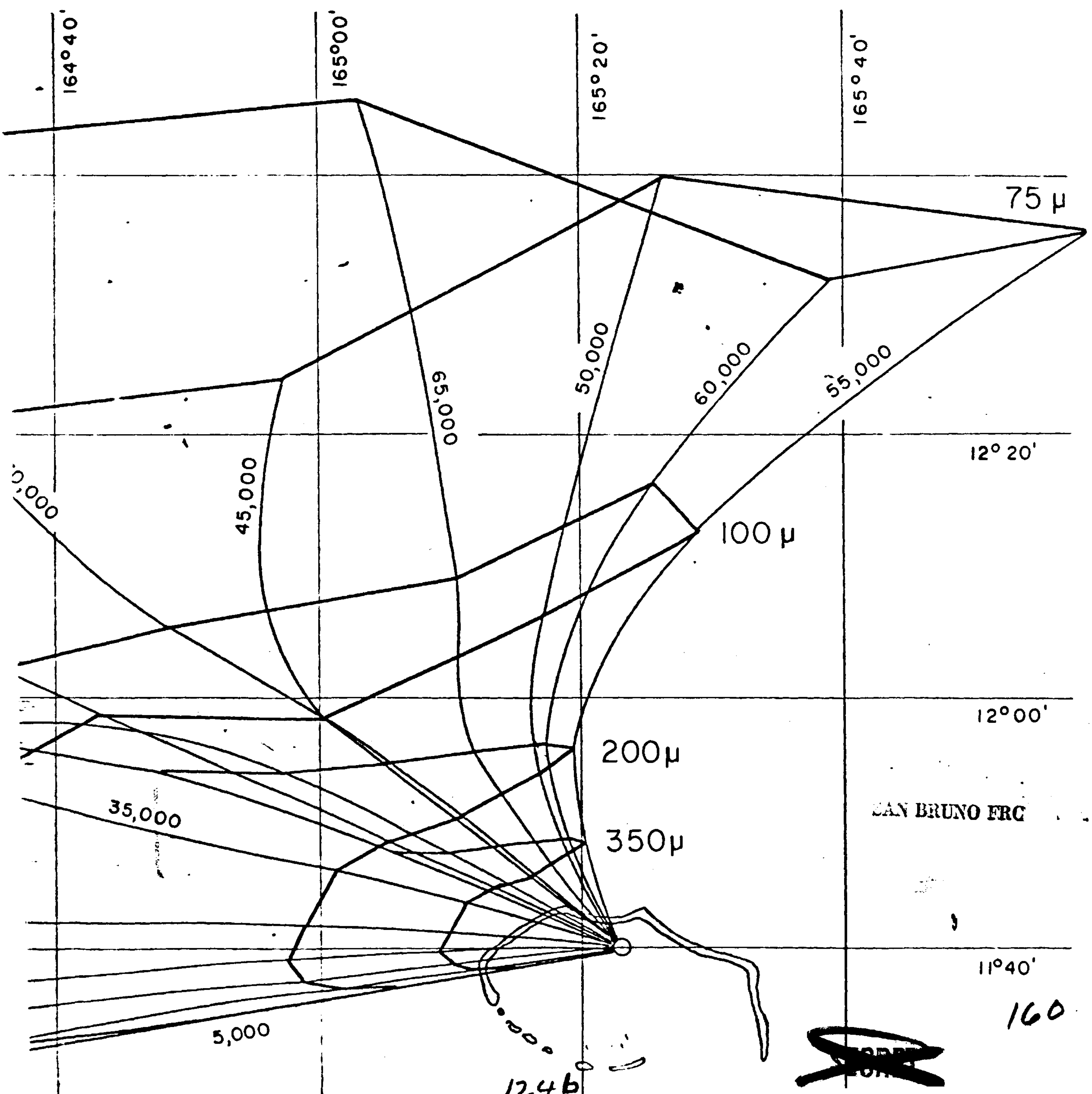
Figure 3.41 Navajo Particle Fall Plot.



Estimated Radiological Cloud

~~SECRET~~


164°40'
165°00'
165°20'
165°40'
75 µ
12°20'
100 µ
12°00'
200µ
350µ
11°40'
65,000
50,000
60,000
55,000
45,000
35,000
5,000
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160

124b

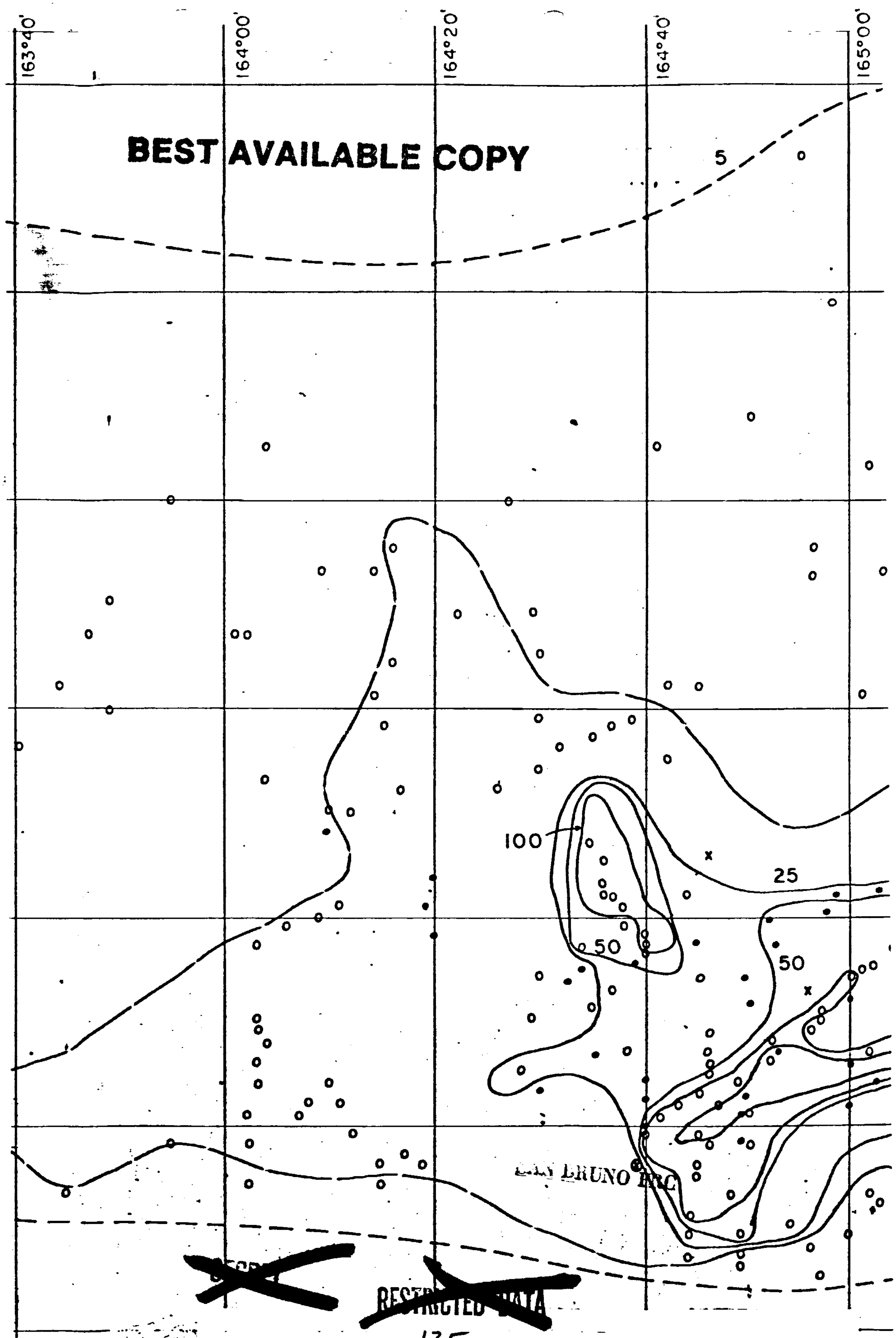

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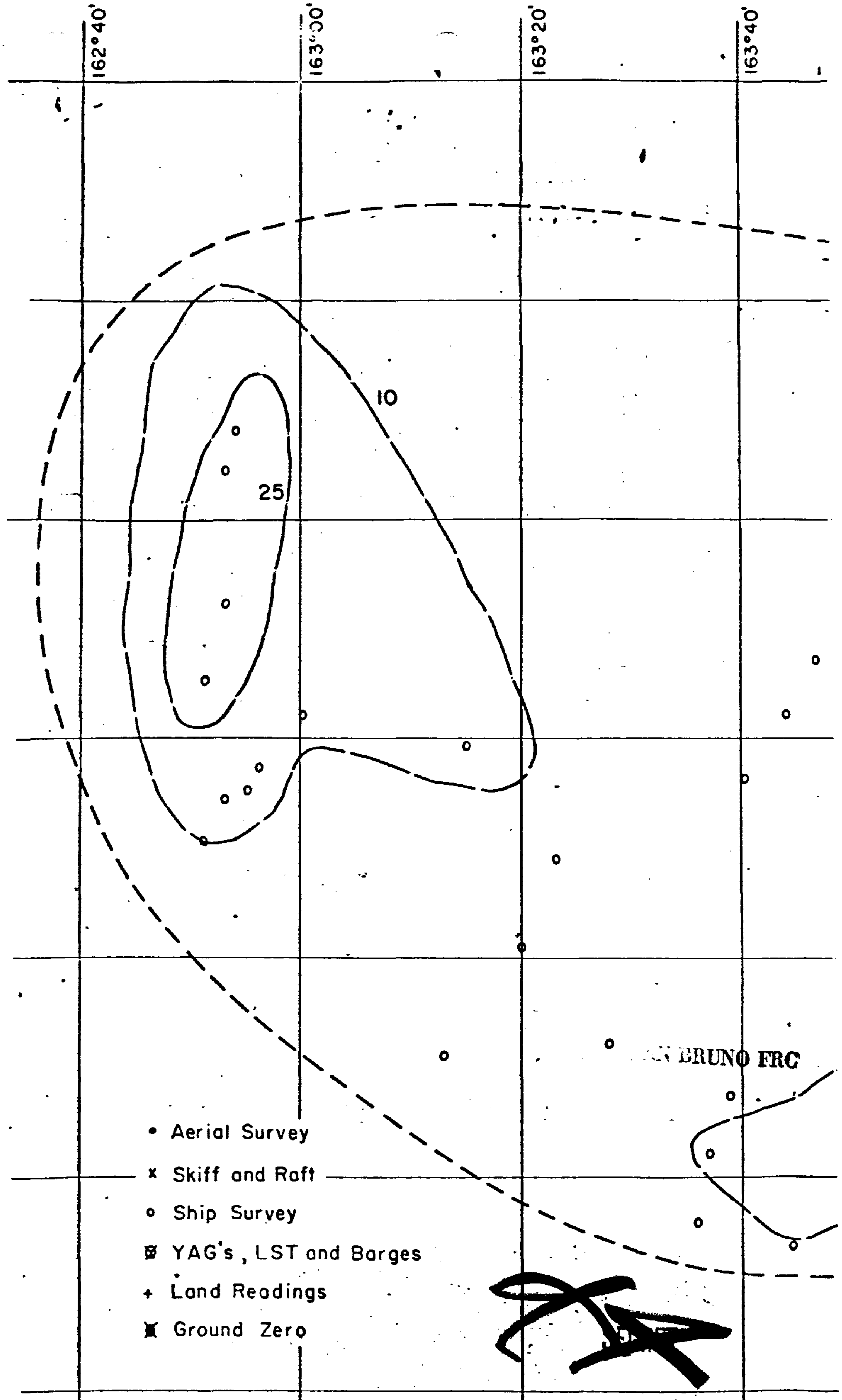
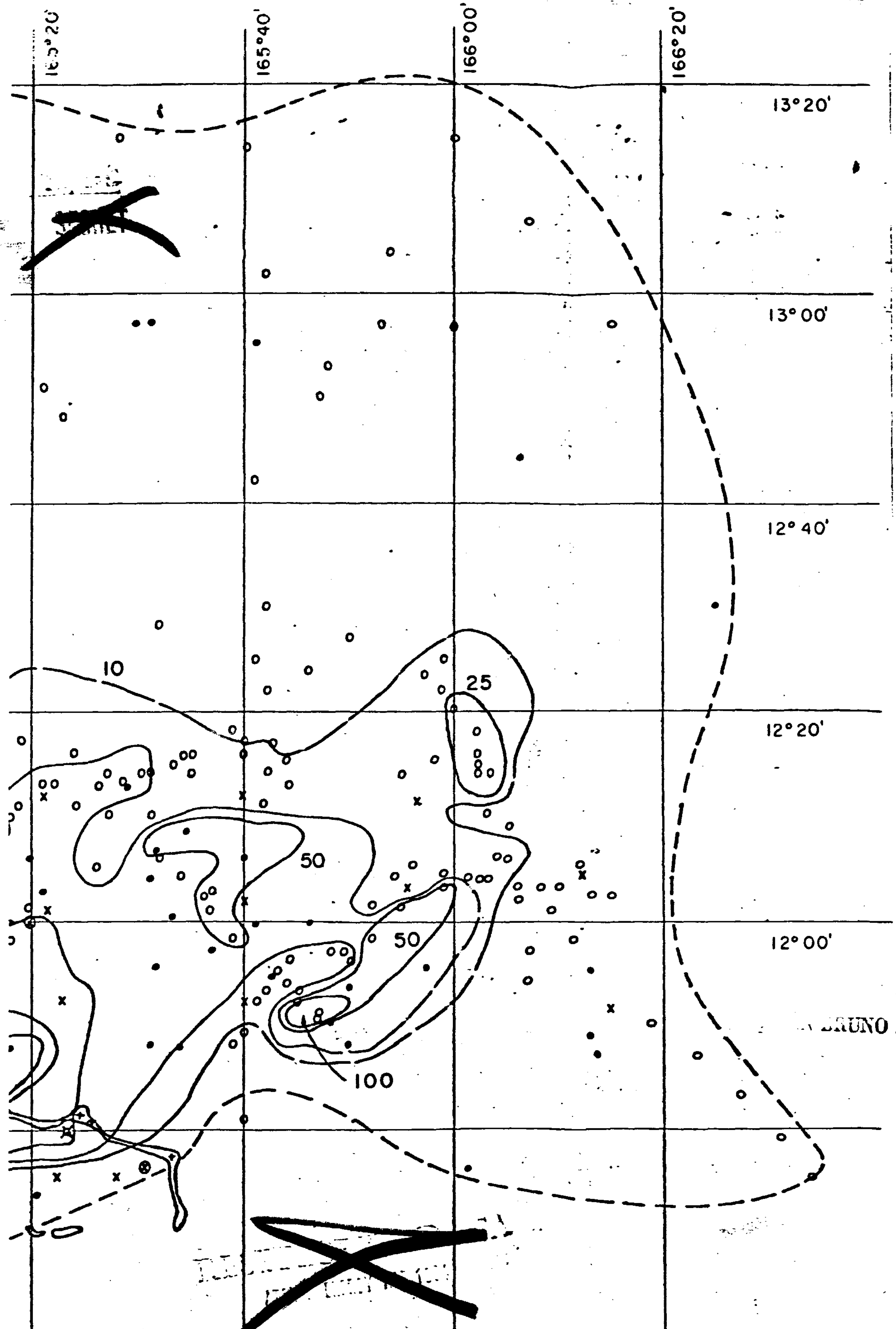
Figure 3.42 Navajo Fallout Radiation Plot. H/1 hour equivalent land exposure rates in r/hr. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.


162°40'
163°00'
163°20'
163°40'
10
25
BRUNO FRC
Aerial Survey
Skiff and Raft
Ship Survey
YAG's, LST and Barges
Land Readings
Ground Zero

125a

162


165°40'
166°00'
166°20'
13°20'
13°00'
12°40'
12°20'
12°00'
11°20'
10
25
50
50
100

125b

163

discussed in Section 3.1.1.5, although the validity of the water survey data is enhanced by the water surface location of the burst, as discussed in Section 3.3.1.4.

The results of a pre-shot survey on Navajo minus two days are indicated in Figure 3.43. The radioactive "slick" which is indicated west of Bikini Atoll is probably due to water from the Zuni and Flathead craters. Since the readings are appreciable, and will not decay rapidly due to the long time since these shots, care must be taken in interpreting data in this region from subsequent fallout surveys.

The experimentally measured effective depth of penetration which was used to reduce the Navajo survey data varied linearly from 20 meters at 10 hours after shot time to 65 meters at 30 hours, and thenceforth remained constant at the value of 65 meters. The decay exponent which was applied to reduce the data to H/1 hour was 1.39 as determined by measurements in the decay tank aboard the M/V HORIZON.

3.3.2.6 Central Time of Arrival Contours. The central time of arrival contours for the Navajo wind situation have been plotted in Figure 3.44. The data points derived from the sources discussed in Section 3.1.1.6 have also been indicated.

3.3.2.7 Ten Hour Exposure Contours. The Navajo ten hour exposure contours, calculated according to the method of Section 3.1.1.7, are presented in Figure 3.45. The corrected data points measured by Project 2.1 are also indicated in the figure.

3.3.2.8 Gross Decay ~~Curves~~ exponent. The observed Np^{239} capture to fission ratio for Navajo was 0.36. The observed gross decay exponents under various conditions of measurement are summarized in Table 3.5.

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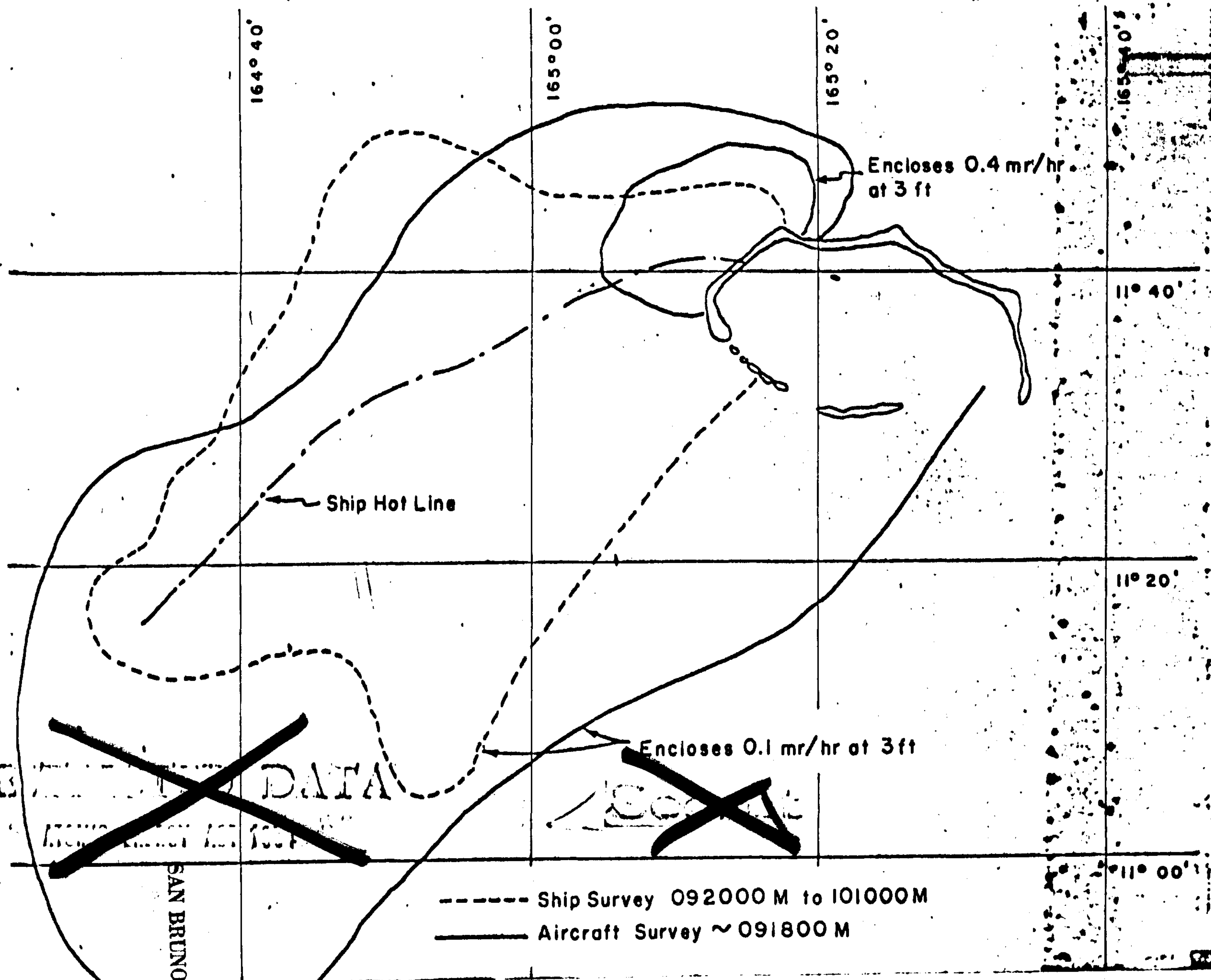

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Figure 3.43 Area of Radioactive Effluent From Bikini Atoll on Navajo Minus Two and Minus One Days.

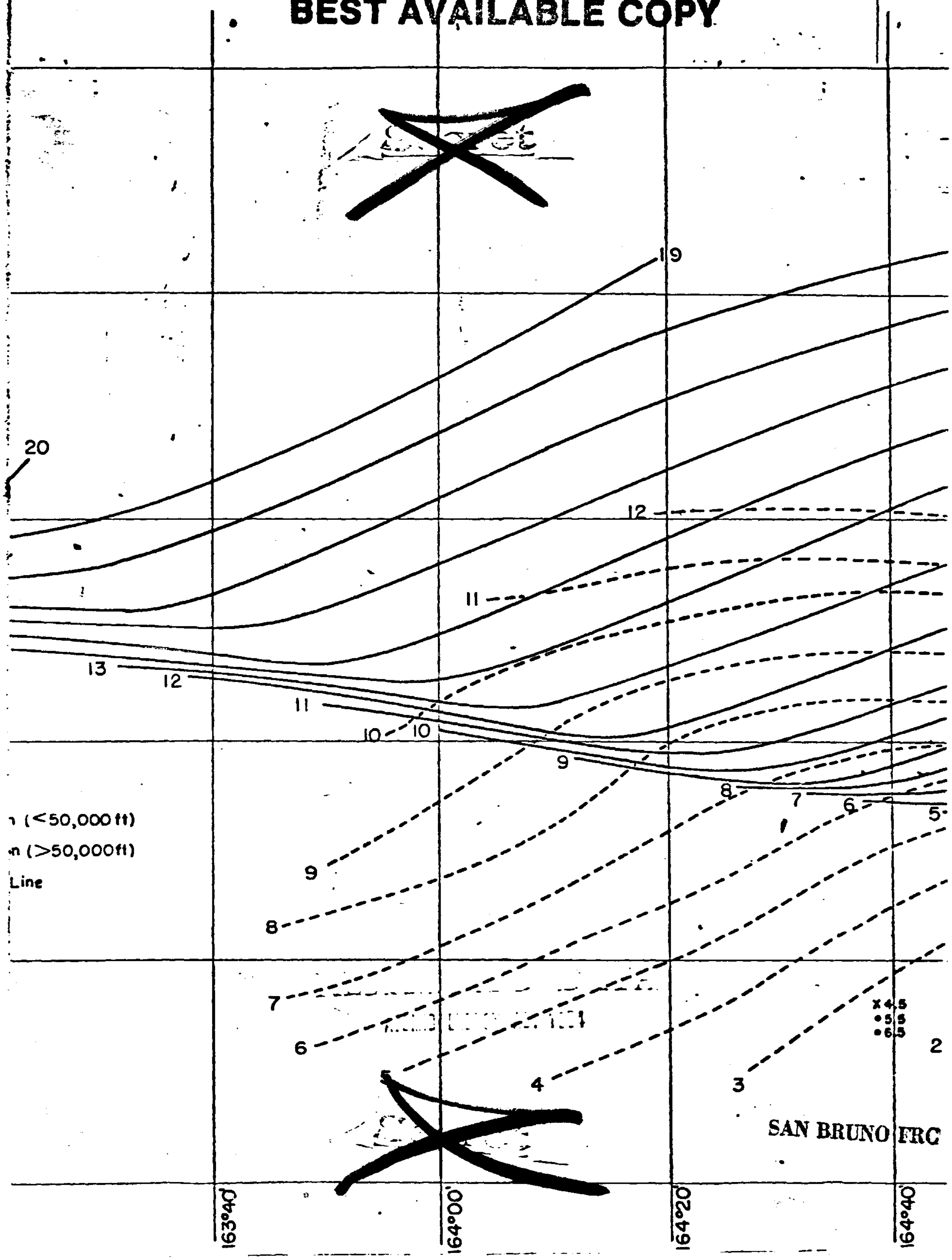
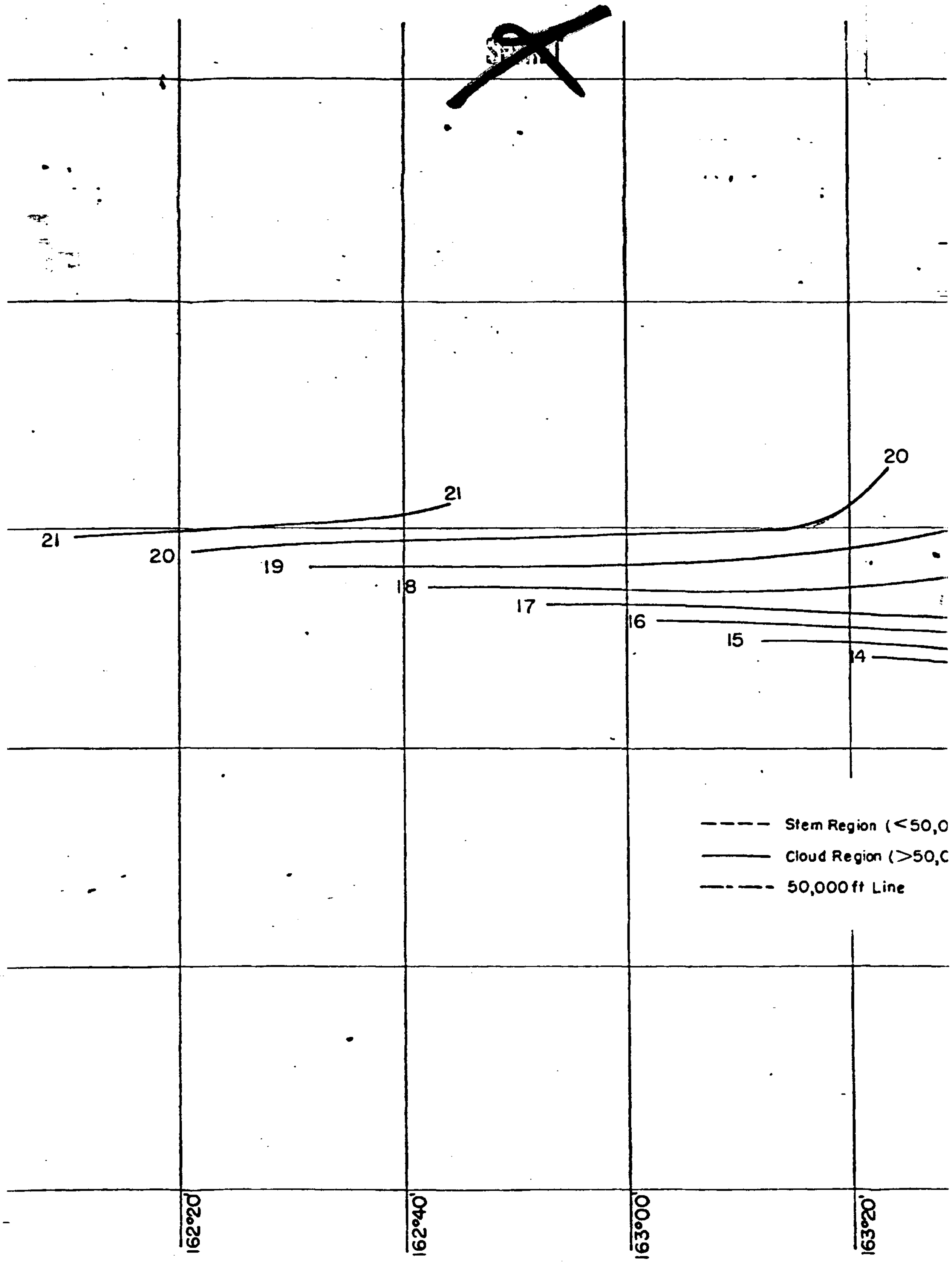


Figure 3.44 Navajo Central Time of Arrival Plot. Times in hours.



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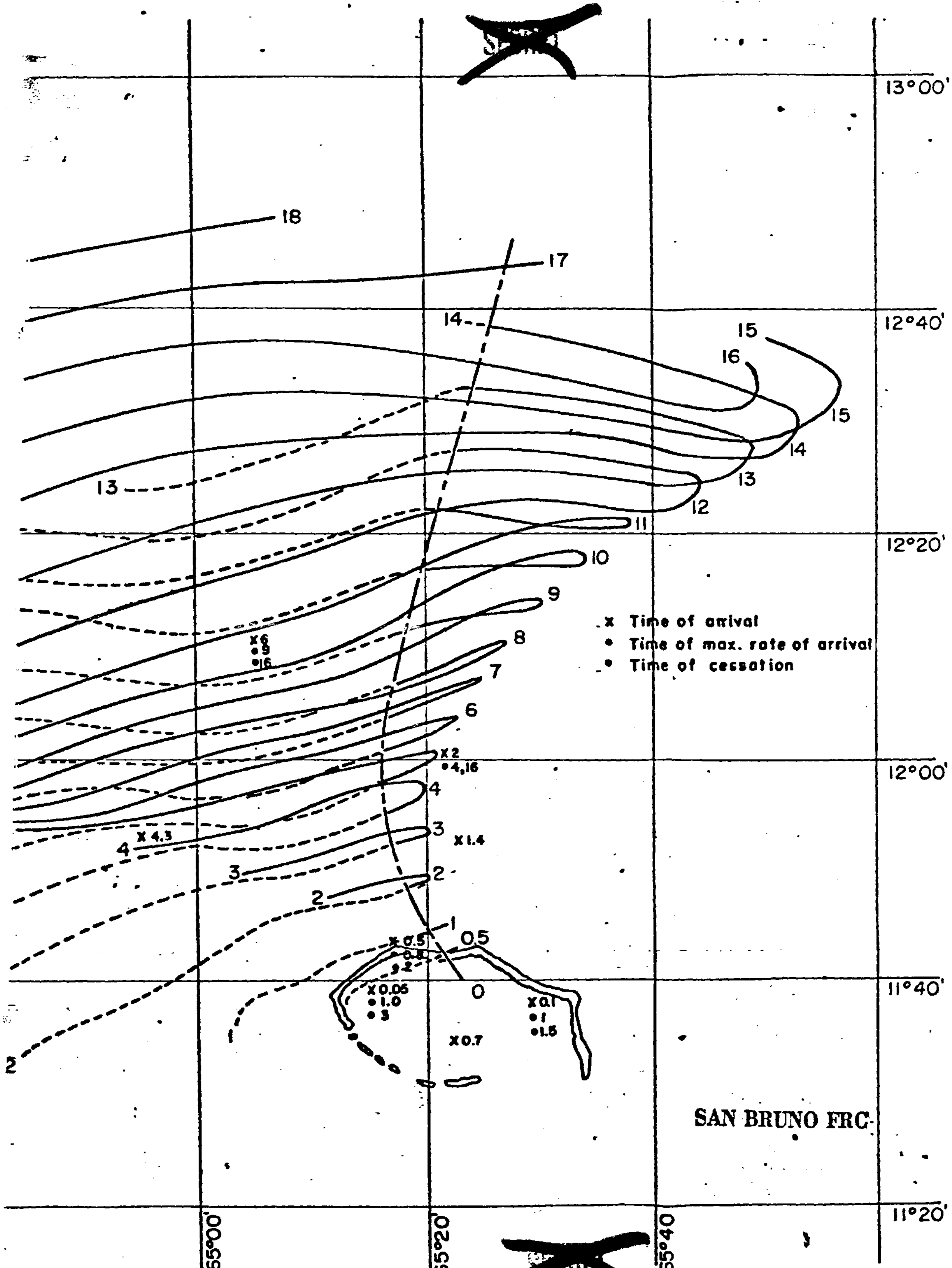
x Time of arrival
• Time of max. rate of arrival
• Time of cessation
13°00'
12°40'
12°20'
12°00'
11°40'
11°20'
165°00'
165°20'
165°40'
18
17
16
15
14
13
12
11
10
9
8
7
6
4
3
2
1
0.5
0
X 6
• 9
• 16
X 2
• 4,16
X 1.4
X 4.3
X 0.5
X 0.05
• 1.0
• 3
X 0.1
• 1
• 1.5
X 0.7
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RD

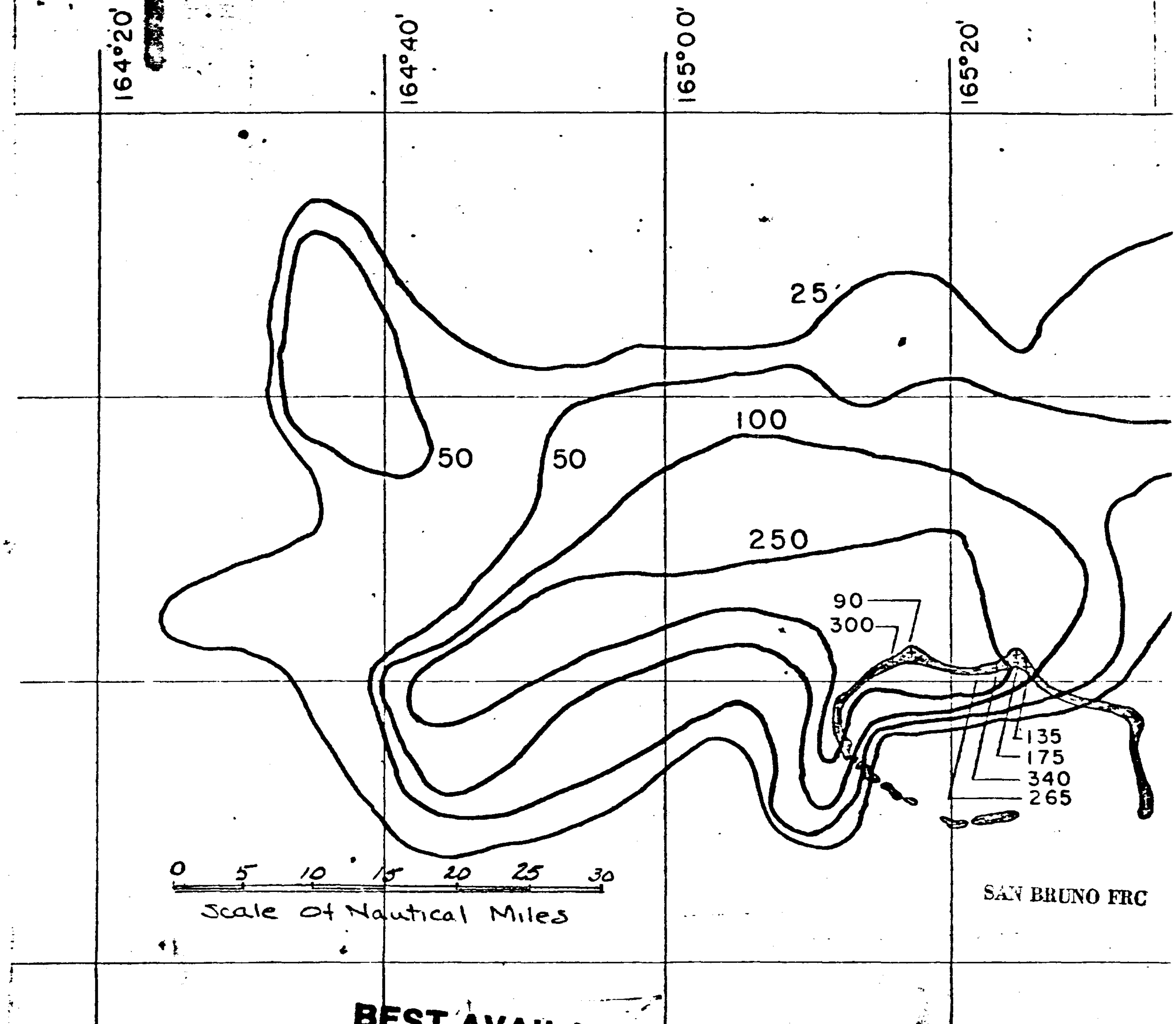

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Figure 3.45 Navajo Ten Hour Exposure Contours.

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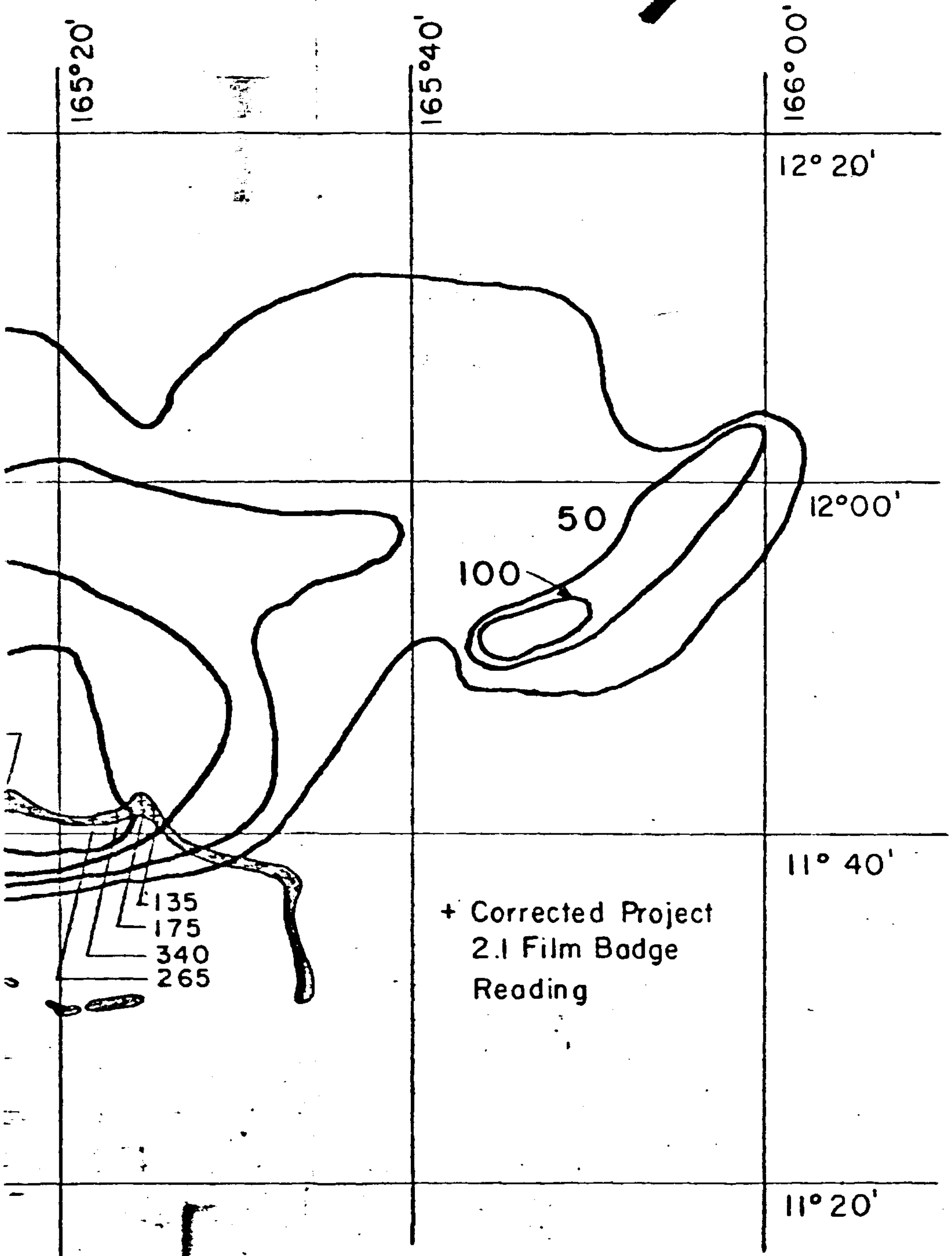

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Exposure Contours.

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TABLE 3.5 GROSS DECAY EXPONENTS FOR NAVAJO

	Time Range (Hours)	5-20	20-50	50-200
Decay Exponent	Gamma Photons*	1.1	0.8	1.1
	Gamma Exposure Rate	-	1.1	1.4
	Beta dis/min	-	1.1	1.2
	Field Gamma Exposure Rate	-	-#	-
	Gamma Exposure in Water	-	1.39	-

* YAG-40 Samples Only

\# Heavy rains on D and D+1 for Navajo apparently removed a large fraction of the contamination from the surface.

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CHAPTER 4

DISCUSSION

4.1 TECHNIQUES OF MEASUREMENT

4.1.1 Introduction. During Operation REDWING a number of widely different techniques were used to perform measurements on the fallout field. Some of these techniques were particularly designed to provide accurate analytical measurements. In some cases the techniques employed are adaptable to the problem of a rapid survey of the radiological situation after the burst of a nuclear weapon in a military situation. The purpose of the following discussion is to describe briefly each general technique and to make a necessarily preliminary and incomplete evaluation of its role in the field tests and its possible application to military situations.

4.1.2 Helicopter-Probe Aerial Survey. This technique involves a radiation sensing probe suspended below a helicopter by a long cable. It is particularly useful in acquiring accurate readings at a controlled distance above a land surface. In general, the readings correspond to measurements by a survey instrument which has been hand-carried to the location, except that the dosage to the personnel has been greatly reduced by placing them above and away from the field in the helicopter.

Over smooth terrain the readings probably give an accurate measure of the density of active sources on the ground. However, the effective source is a circle of radius 300 to 500 feet, and any terrain irregularities which would shield part of the source from the instrument would cause the readings to be low. The meter readings would still represent the dosage to personnel

located at that position, but would not be a measure of the surface density of radioactive sources (curie/m^2).

The applicability of the technique to military situations is limited to obtaining readings at a few critical locations in a fallout pattern. A small cleared area is required and the present design of probe is not useful over water. The accuracy of the measurement is greater than needed for a complete survey and the time involved for the survey of an extensive fallout area is too long.

4.1.3 Collection of Fallout Samples. The direct collection of fallout samples is an essential part of the analytical program at weapons effects tests. However, the question to be considered now is whether it is good technique for evaluating the surface density of active material.

The laboratory measurements on fallout samples to determine their absolute activity can be made very accurately with fixed geometry counting techniques. The main limitation is in the actual collection of the sample. The requirements for the collector are that it produce negligible disturbance in the air flow pattern and that it retain any material impinging upon it. These requirements must be met over all angles of incidence, corresponding to various particle sizes, and for particle types varying from a fine aerosol to a dry dust. Further experimentation is needed to develop such ideal collectors.

Clearly the collection of material is not a practical matter under operational military situations, since the collectors can not be placed before the event and there is a long time delay involved with recovery of samples and transportation to an uncontaminated laboratory.

4.1.4 Radiation Readings on Ship's Deck Surfaces. The deck surface of the YAG's represented a source field large enough that only a small correction was needed to convert an ~~dose~~ exposure rate reading above the deck to an infinite field reading. However, preliminary data indicate that the fine aerosol type of material does not readily collect on the deck surfaces and large dry material may be blown off. Therefore, such deck readings may tend to be low and must be correlated with other sources of data.

4.1.5 Radiation Versus Depth Profiles in the Ocean. When the nature of the burst is such that most of the fallout activity will be dissolved in the surface layer of ocean water, the radiation versus depth profile is a very useful technique for making an absolute activity measurement. The observations during Operation CASTLE and the present experiments indicate that most of the activity remains above the thermocline (80 - 150 meters depth) for periods of many days and therefore is accessible to direct measurement using simply constructed probes. These readings are calibrated in terms of curies/m^3 by analyzing water samples in a laboratory.

The limitations of this type of measurement for land surface (island) bursts, in which much of the activity is associated with sizeable particulate, are still undetermined. From the measurements performed at Operation REDWING it appears that at least half of the total deposited active material remains in the surface layer, but this fraction may vary greatly with position. For example, the close-in high exposure rate areas may have most of the material, which is associated with the larger particles, disappearing below the thermocline. Since these areas only ~~represent~~ received a small portion of the total ~~weapon~~ fallout, this would not affect the conclusion above.

One feature of the measurements that needs continuous careful check is the problem of probe contamination. Since the radiation levels in the water are invariably quite low, it is important to make sure that ~~a small~~ The amount of activity deposited on the probe is maintained at a low enough level as not ~~is not~~ affecti~~ng~~ to affect significantly the answer.

4.1.6 Radiation Readings in the Surface Ocean Layer. A relatively rapid survey of ocean fallout areas can be made using a probe towed behind a ship which measures the radiation field just below the water surface. Interpretation of these readings in terms of total fallout material involves the assumption of an average depth of mixing, guided by the results of the radiation versus depth profiles. This technique must therefore be applied with care, particularly in regions of recent fallout and regions where fallout was in the form of large particulate.

4.1.7 Radiation Readings in Air Over the Ocean. Radiation readings taken in an airplane flying above contaminated ocean water, when corrected for the absorption of the air, measure the concentration of activity in the surface layer of water and, therefore, are subject to the limitations discussed in Section 4.1.6. In addition, the readings at practical flight altitudes (>300 feet), represents averaging over an area whose radius is of the order of 1,000 feet, and therefore this method must be used with care in areas of high gradients in the radiation field. However, the survey can be performed faster than that performed by a surface vessel and therefore can outline the fallout pattern in a short time.

In performing these aerial surveys it is important that the aircraft arrive over the fallout area after the radioactive material has ceased to come down. A relatively small amount of contamination alighting on the

aircraft can easily mask the radiation from the water surface, because the water greatly dilutes the radioactive sources.

4.1.8 Radiation Readings in Air Over Land. During Operation REDWING the technique of taking radiation readings in an airplane flying over land was not used extensively because of the small amount of land area present. This method has been used for tests at the Nevada Test Site.

The principal limitation ofthis technique is in the region of high fields, and associated large gradients. Since the readings do represent averages over sizeable areas the features of the pattern will be smeared out over distances of the order of 1,000 feet. Furthermore, over irregular terrain the airplane may be forced to fly higher than 300 feet and hence average over a slightly larger area.

Contamination of the aircraft must again be avoided, although the problem is not as critical as it is on a survey over water. On the other hand, the higher readings from the land increase the problem of dosage to the aircraft crew.

The aerial survey system is applicable to practical military situations since it does roughly outline the areas denied to personnel operations in a fairly short time. However, care must still be taken because local hot spots in the field may be smoothed out by the survey, which could nevertheless inflict serious dosages on personnel.

Readings taken by helicopters hovering at low altitudes above land surfaces have been used principally in the RadSafe surveys during Operation REDWING. Apart from the slight decrease in dosage to personnel compared with ground operations, this method has additional merit when used over rough terrain. If it is desired to evaluate the density of

active sources, rather than the dosage to personnel at a particular location, a meter held at a moderate altitude is less likely to be shielded from part of the source field than one held at 3 feet over the ground. Before such methods are used for accurate work, however, it will be necessary to perform careful altitude absorption calibration experiments.

4.1.9 Droppable Radiation Detector-Telemeter Units. A technique which has been tested unsuccessfully at Operation TEAPOT and Operation REDWING, but which has promise if further developed is one involving the use of a radiation detector and telemeter unit which can be dropped onto a contaminated area. The radiation readings are then received at the drop aircraft which can retire far enough away to be out of the intensive radiation.

This technique is particularly applicable to measuring the intense fields near the crater from a nuclear burst. It is limited to a number of data points equal to the number of detector-telemeter units available. The fact that the equipment can continue to send information over a long period of time makes it particularly useful for field tests since it supplies decay as well as instantaneous exposure rate data.

At REDWING, this technique was known as the "Beach Ball Project" and was undertaken as an effort incidental to that of a major project and lack of results should not be used as the basis for prejudice against this technique.

4.2 LIMITATIONS OF PRELIMINARY DATA

4.2.1 Introduction. This presentation of preliminary data and the ensuing discussion were completed only a few weeks after the last event in Operation REDWING. Therefore, it is to be reemphasized that the data are subject to large changes and their interpretation may also be altered

when the final reduction of the data is complete. However, the results of the fallout program are of military importance immediately, and it is to be hoped that the errors introduced by presenting preliminary and possibly incorrect data will be more than compensated by the advantages of having a preliminary picture available at an early time. It is the purpose of the following discussion to evaluate the sources of additional data and the most probable recalibrations which will be provided by the data in the Program 2 projects' final reports. The fact that the data is preliminary and some changes can be anticipated with time should not be construed to mean that a fairly good picture of the fallout problem in operational situations is not available at this time.

4.2.2 Radiation Measurements in the Nuclear ~~Cloud~~ mushroom. As discussed in Section 3.1.1.2, the preliminary data on exposure rate versus position in the nuclear ~~cloud~~ mushroom is subject to large changes - primarily from the following sources: (1) The identification of a radiation record with a particular rocket may be changed. If this becomes necessary, a major change in the positions of the readings will result. (2) A redetermination of the zero time on the traces is likely to shift the radiation readings along the trajectory. (3) Recalibration of similar detectors, particularly in high radiation fields, will probably indicate a nonlinearity in the response curve, which may change the values of the higher readings. (4) The trajectory data will probably be changed slightly.

4.2.3 Land Surface Readings. The land surface readings are probably subject to the least change compared to the remainder of the data. The principal changes will come about in the use of experimental decay curves, or at least theoretical decay curves based on the measured capture to

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fission ratio, rather than the simplified $t^{-1.0}$ and $t^{-1.2}$ relationships.

4.2.4 Water Survey Readings. The water survey readings will be subject to major recalibrations based on an analysis of the observed depths of penetration as a function of time after arrival and position in the fallout pattern and on absolute counting of the water samples. The average depths of penetration used in this report represent at best a method of presenting the data in a relative fashion indicating the rough magnitude of the contamination. When such a recalibration is performed the calculation of the total material observed, and hence the fraction of the weapon locally deposited, can be performed in a significant fashion. At present such a calculation serves only to demonstrate that the readings are of the correct order of magnitude, and even a comparison of the weapon fractions between different events is doubtful.

Preliminary measurements on Tewa fallout made at NRDL has demonstrated a large variation of solubility rate and gamma spectra with time of contact with water (reference 30). Complete analysis of various factors, including variation of particle size with distance from ground zero and dependence of settling rate on particle size and solubility, is required to establish a fully reliable set of contours.

4.2.5 Aerial Survey Readings. The aerial survey readings are subject to the same recalibrations discussed in Section 4.2.4 and in addition must be recorrected for the air absorption. Absorption experiments performed at Operation REDWING and some theoretical calculations should provide the basis for this recalibration.

4.2.6 Sample Readings. The relative radiation levels derived from

sample readings are probably subject to the largest changes. Aside from the problem of collection efficiency, the values used in this preliminary report represent crude monitor readings of the samples measured in standard geometry situations, but under conditions of appreciable background radiation. Only the careful analysis and counting, done later in the continental laboratories, can correctly determine the relative fields and can, in addition, furnish the absolute surface density of active materials.

4.3 DISTRIBUTION OF ACTIVITY IN THE STABILIZED CLOUD

4.3.1 Introduction. There is no strong reason to expect the distribution of activity in the stabilized cloud to be a function of the geological environment of the burst point, and no experimental evidence to indicate any such phenomenon. Therefore, the observations on all the documented shots will be discussed together, keeping in mind that for comparison purposes the readings should be divided by the fractional radiological yield to be reduced to the common basis of a 100 percent fission weapon.

4.3.2 Rocket Measurements. The rocket exposure rate measurements indicate that the active material is not distributed uniformly through the cloud. As a matter of fact, if the material were distributed proportionally to the air density, the readings should be constant in the cloud and this is not the case. The individual exposure rate traces generally indicate a rapid peaking and subsequent decline while the rocket is still within the visible cloud. Therefore, as demonstrated particularly in Figures 3.2, 3.4 ~~[illegible]~~, 3.25 ~~[illegible]~~, and 3.35 ~~[illegible]~~, most of the activity is probably in a thin layer, which is ~~probably~~ located just above the base of the visible cloud ~~mushroom top~~.

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[redacted]

The radial variation is also interesting. There is some evidence for a slight decrease in concentration at the center (above the stem), a peaking at a distance of about one-third of the visible cloud radius, and a subsequent decrease to the outer regions where the concentration appears to be about one quarter of its peak value. Crudely speaking, the active material appears to be concentrated as a "washer" with some material of lesser activity spread into the rest of the visible cloud.

The limited observations in the stem indicate peak activity concentrations less than those directly above in the cloud by a factor of ten or more. The radiological stem has dimensions no larger than the visible stem. Therefore, in view of the relative volumes, an inappreciable amount of material exists in the stem at the altitudes observed.

4.3.3 Manned Aircraft Measurements. The actual exposure rates measured by the aircraft penetrations were in general lower than those calculated from the rocket data at the same altitudes. The reason for this discrepancy is not yet clear. Of course, no aircraft penetrations were performed as early as the rocket flights on these events, but previous experience with the penetrations does indicate the $t^{-2.0}$ decay extrapolation of the aircraft data to be an overestimate, if anything.

The observations of the aircraft in the stem support the conclusion that the concentration of activity is small compared to that in the ~~mushroom-top~~ cloud. These flights, as well as the rocket data, only draw this conclusion for the upper parts of the stem at the times involved. They shed no light on the question of heavy particulate which might have fallen before the observations were made, or for the part of the stem below 25,000 feet.

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4.3.4 Fallout Pattern Indications. At present no complete analysis of the fallout radiation pattern in terms of the particle fall plot and the finite cloud dimension have been performed. However, some preliminary conclusions can be drawn from the data. It should be noted that the H+1 hour exposure rate at a particular point should be determined roughly by the activity in the initial cloud associated with the height and particle size intervals which encompass the point on the particle fall plot, divided by the area between the corresponding height and particle size lines on the plot. Therefore, whenever the height lines come close together there should be an enhancement of the radiation field due to the wind structure and not because of any properties of the initial cloud. A limit to the above statement is implied by the finite horizontal dimensionsof the cloud, which spread the activity over a minimum area even if there is no shear in the wind structure.

The following features of the fallout radiation pattern appear from a cursory inspection combined with the particle fall plot:

a. The outer boundary of significant fallout seems to be at approximately the 60 micron line. However, the area up to the 75 micron line is subject to such low activity concentrations arriving at late times that it is not of concern in military operations.

b. The effective cloud diameter for the larger particles must be smaller than the visual cloud diameter to explain the rapid decrease of contamination on islands in the upwind and crosswind directions. A careful activity versus particle size analysis for the land station samples will be needed to establish this effect quantitatively.

c. Large particles from the lower stem region may produce very intense radiation areas a few miles downwind from the shot point. The Zuni Shot gave no indications of this effect, but all the barge shots produced heavy contamination on Sites Able and Charlie. This contamination could not be crosswind deposition from the cloud, because Site How, which was almost an equal distance in an opposite direction for Navajo and Flathead, as well as the YFNB barge which was closer, did not show these high readings.

d. The most significant fallout comes from the base of the nuclear cloud. The "hot line" in the pattern invariably fell in the direction corresponding to 50-60 thousand foot lines. The concentration of altitude lines due to the wind reversal at these altitudes is not enough to explain the magnitude of the effect. Furthermore, the regions that received fallout from higher parts of the cloud were contaminated to a small extent. For example, on event Tewa a part of the 75-80 thousand foot fallout actually fell on Eniwetok Atoll, but did not produce enough contamination to warrant evacuation.

4.4 CHARACTERIZATION OF FALLOUT MATERIAL

4.4.1 Introduction. Only fragmentary information on activity versus particle size distributions was available at the early date of this report. Most of the data on the particle sizes at various positions in the initial cloud will come from analysis of the intermittent fallout collector samples in which the particle size and time of arrival can be correlated to a unique position in the cloud. Since this information must come from more detailed analysis, only preliminary data as gathered from the correlation

between the fallout radiation plot and the particle fall plot can be discussed here.

The chemical and radiophysical analyses of the fallout material are also matters for continental laboratory work. However, the resulting data will deal mainly with fractionation and hence with theories of formation of the active material. At present, it is not possible to include these theories into fallout model calculations in any significant fashion. Fractionation may affect the radiation dosage through its modification of the gamma energy spectrum and the decay curve, but such effects are not well enough known to be incorporated now.

The physical appearance and chemical nature of the fallout has been roughly evaluated at the land stations and in the YAG 40 laboratory. Further data on other samples are being produced in the home laboratories. For example, as stated in paragraph 4.2.4, some information has already been developed on the characteristics of particle solubility in a Zone of Interior laboratory.

4.4.2 Land Surface Burst. The data on the particulate matter for land surface bursts presented in this report is applicable only to land consisting of coral with nearby salt water. Therefore, some of the conclusions may have to be modified when discussing bursts over other, more usual, types of ground.

A cursory inspection of the particle fall plots and fallout radiation plots for Zuni and Tewa indicates that the most intense regions are associated with particles in the 100-200 micron size range. The LaCrosse plots indicate that the activity on the surface appears to increase when going

from 350 toward 200 micron particles, although the documentation did not extend to the sizes below 250 microns. Since the intense pattern to the west of Tewa appears to be short, any important lower stem activity is probably associated with very large particles.

In general, the fallout material from the land surface bursts was quite dry, even though there was an appreciable amount of water in the environment of the shot point. The chemical nature of the material was in general modification of coral, namely $CaCO_3$, $Ca(OH)_2$, and some CaO. Usually other materials present near the shot point also appeared in the fallout, e.g., the iron in the LaCrosse event.

4.4.3 Air Burst. The Cherokee Shot at Operation REDWING represented an air burst over water. The extensive survey of the downwind areas subsequent to this detonation established that the fallout radiation levels were not of military importance for this type of burst. Clearly the fission product material must have become associated with particulate so small that the local fallout was negligible. In this case the problem has become one of the world-wide contamination type and therefore is beyond the scope of this report. BEST AVAILABLE COPY

The requirement still remains to evaluate the contamination from a megaton yield weapon detonated under minimal air burst conditions over land. To date it has been established that air bursts of kiloton yield weapons above land and megaton yield weapons over water do not produce significant local contamination. However, the probability that an air burst of a megaton yield weapon over land produces contamination is ~~as large~~ the same after the Cherokee test as it was before. The reason is that the mechanisms discussed in Section 1.2.3 by which such a burst could produce local contamination

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do not apply to a burst above water. If surface material (sea water) from Cherokee had caught up with the fireball in time to have the fission products deposited on it, the water would have undoubtedly evaporated. Recondensation of the water, if it occured at all, would probably be in the form of very small droplets which would not be locally deposited.

Therefore, it may be unlikely that bursts of a megaton yield weapon over land produce significant local contamination, but it is possible and the Cherokee test does not negate such a possibility.

4.4.4 Water Surface Burst. The effective particle size for water surface bursts appears to be much the same as for land surface bursts. Again the intense regions of the fallout pattern seem to be associated with 100-200 micron material. Furthermore, the stem region to the west seems to have the same character as for land surface bursts.

One extra phenomenon which can easily occur in this type of shot is a time change of the effective size of a particle (droplet). As water evaporates or condenses on the drop it could fall according to various different sizes as it comes down. In addition, ice particles which result from frozen drops will have different fall characteristics than the drops. Sublimation of ice particles will also introduce variations. Phenomena of this nature could introduce major modifications into the particle fall plot, which present knowledge has no way to predict.

The ~~nature of the~~ material from water surface shots seems to be predominantly salt. The very high concentration of salt may imply a large degree of evaporation has taken place during the particle's travel earthward. The actual activity seems to be associated with a very small nucleus amidst this slurry type salty droplet.

In general it appears that the prediction of fallout from water surface bursts can be made using similar parameters to those for land surface bursts.

4.5 RELATIVE AREAS OF CONTAMINATION

4.5.1 Introduction. The characteristic dimensions of a fallout pattern, e.g., downwind distance, crosswind distance, etc. will depend quite markedly on the existing wind profile. For example, a wind profile having very little directional shear and strong velocities would be expected to produce a long, cigar shaped pattern whereas the high shear situation which is common in the Pacific Proving Ground produces a wider and shorter pattern. If there is any hope of characterizing the fallout region by any parameters characteristic of ~~the~~ a weapon and its environment and relatively independent of the wind conditions, ~~the~~ such parameters ~~should be chosen to~~ might be the areas enclosed by the various radiation contours. In particular, the integral of the H+1 hour exposure rates over ~~the~~ a given contour area ~~must~~ might be characteristic of the detonation only, ~~since~~ it represents the portion of the radiological yield which has been deposited ~~[illegible]~~ within the contours.

4.5.2 Background. The only surface events previous to Operation REDWING on which sufficient fallout information was available to infer areas of contours were the JANGLE surface shot and some of the Operation CASTLE events. Of the latter ones, the CASTLE Bravo surface shot contours have only been predicted from an analysis of the winds with some normalization from sparse data points. The water survey data from Shots Yankee and Nectar, Operation CASTLE, yielded contour area data for water surface (barge) shots. For reference, these data have been summarized in Table 4.1

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TABLE 4.1 SUMMARY OF PREVIOUS SHOTS' EXPOSURE RATE CONTOUR AREAS

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NOTE: *Reference 10.
#Reference 11.

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The above contour areas, except the JANGLE surface data, were multiplied by a factor of 4/3 and presented on the plot of Figure 4.1 of area versus one hour exposure rate. The factor was desired to normalize all data to a hypothetical 100 percent radiological yield weapon. The predicted contour areas for 50 KT, 500 KT, and 5 MT bursts from Reference 29 have also been indicated on Figure 4.1.

An estimate of the radiological yield accounted for by the fallout data can be derived by a rough numerical integration of the exposure rate over the area. (See Appendix D).

<u>4.5.3 REDWING Results</u>. The data on the areas of the contours drawn from the preliminary data of this report have been presented in Table 4.2. These data from the two land surface shots, Zuni and Tewa, and the two water surface shots, Flathead and Navajo, have also been presented in Figure 4.2. For the figure, the radiation levels were in all cases [redacted] weapon. THESE CONTOURS ARE EXTRAPOLATED FROM PRELIMINARY DATA AND MUST BE USED WITH CAUTION. See Appendix E for estimates of the fraction of activity in the local fall out.

<u>4.5.4 Ten Hour Exposure Areas</u>. The ten hour exposure areas are not of direct significance to fallout models, but are of primary concern in the military effects of fallout. The relative areas of the various contours have been listed in Table 4.3 for the four REDWING shots on which the Program 2 projects gathered complete fallout data. The data have also been plotted in Figure 4.3, where the exposure values have been normalized to a 100% radiological yield weapon.

<u>4.5.5 Comparison</u>. In general the differences of the contour areas between the [redacted] - are not significant in view of the approximations used in the preliminary data reduction.

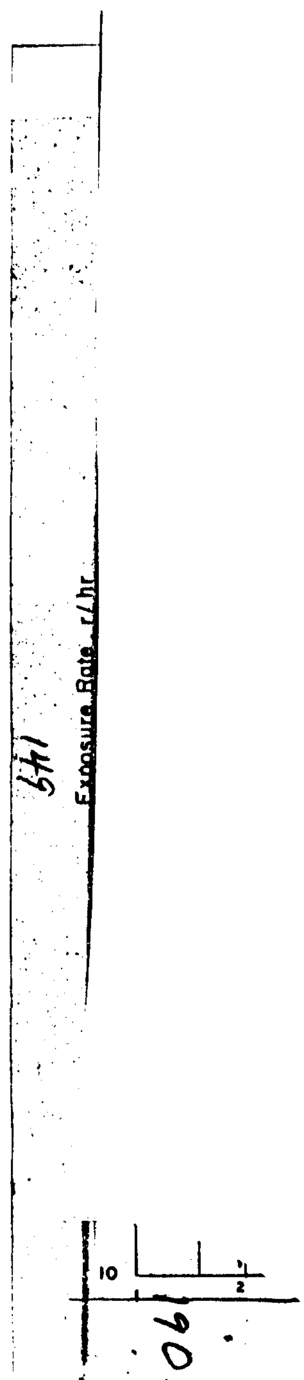

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Figure 4.1 Areas of Exposure Rate Contours on Previous Shots. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

Area , sq mi

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Figure 4.2 Areas of Exposure Rate Contours on REDWING Shots. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

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TABLE 4.2 SUMMARY OF EXPOSURE RATE CONTOUR AREAS, OPERATION REDWING*

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NOTE: # Very doubtful - represents rough estimate of boundary of fallout pattern.

* CONTOUR AREAS EXTRAPOLATED FROM PRELIMINARY DATA AND MUST BE USED WITH CAUTION.

TABLE 4.3 SUMMARY OF TEN HOUR EXPOSURE CONTOUR AREAS, OPERATION REDWING*

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NOTE: *CONTOUR AREAS EXTRAPOLATED FROM PRELIMINARY DATA AND MUST BE USED WITH CAUTION.

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In particular the curve for Navajo is probably too high, because the [redacted] and the resultant low activities in the outer regions of the fallout area, caused the background radiation levels from previous shots to have an appreciable effect. Since in the present data reduction the pre-shot background radiation was not subtracted, the contour areas as presented are probably too large.

Comparison between the values predicted on Page 97 "Capabilities of Atomic Weapons," Reference 29 and those measured in these experiments is more uncertain than a comparison between events, because any errors in the ~~absolute~~ conversion factors ~~may contribute appreciably~~ used in reducing fallout data are uniformly applied. In general, the measured contour areas are larger than the predicted values. However, an error in the conversion from radiation measurements in the water to the calculated value over an equivalent land surface could have this effect. Laboratory work being performed at present, as well as more complete data reduction, should resolve the questions about conversion factors.

No comparison between experiment and prediction of crosswind distance, downwind distance, and ground zero circle diameter can be made at this time. Some of these distances are quite sensitive to the actual wind conditions. Since the wind profile which usually existed on shot days at the Pacific Proving Ground is not typical of the continental winds, there would be no significance to such a comparison.

4.6 EXAMPLES OF FALLOUT PATTERNS IN THE CONTINENTAL UNITED STATES

4.6.1 Introduction. To perform an accurate prediction of the fallout pattern from a burst at a particular location, a complete analysis of the REDWING data in terms of a fallout prediction model should be performed, which

would then be applied to the calculation of the fallout from the assumed wind profile. However, the accuracy of the preliminary data does not justify such a detailed analysis in the limited time available for the preparation of this report. Therefore the patterns have been constructed from the following assumptions:

a. The assumed weapon was a 5 MT total yield, [redacted] land surface burst.

b. The ten hour exposure contours had the same areas as those observed for Tewa.

c. The location of the ten hour exposure contours was chosen to represent an estimate of the relative positions in the fallout pattern. The contours around ground zero were slightly distorted and reproduced with the same area. The outer boundary of the pattern was determined by the particle fall plot expanded by a cloud diameter of 30 miles in the small particle size areas, and by about 5 miles around ground zero. The center of the downwind maximum, which clearly occurred for both Zuni and Tewa, was chosen at the 50,000 feet, 100 micron point in the particle fall plot. The effect of the strong non-shear wind pattern on the continent is to displace this maximum about 150-200 miles downwind, although during the tests it was approximately 50-100 miles from ground zero. A detailed model calculation will be needed to verify this position. Actually the entire area between ground zero and this maximum will probably receive a lethal dose for personnel exposed for 10 hours to the fallout.

4.6.2 Comparison of Wind Profiles. The wind profile which was incorporated into the particle fall, time of arrival, and fallout plots given in Chapter 3

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was generally as follows: Easterly winds (Trades) up to 20-25,000 feet with speeds of 10 to 20 knots, South westerly winds (Westerlies) to 50-55,000 feet with speeds of 20-30 knots, and then turning through the south to the upper Easterlies with speeds increasing from 15 to 80 knots with altitude. The two major shear areas (20-25,000 feet and 50-55,000 feet) appear to be typical of mid-Pacific torrid latitudes. On the other hand, the United States and most of Europe lie in temperate latitudes which are characterized by winds generally from the west which have little directional shear. Consequently there will be a different shape to the fallout pattern under these conditions. For illustration, representative winter winds have been selected to distribute the fallout from hypothetical [redacted] surface bursts at Washington, D. C. and Santa Monica, California.

<u>4.6.3 Washington, D. C. and the East Coast</u>. Figure 4.4 is taken with ground zero at the Pentagon Building. The fallout pattern[1] encompasses a good portion of the District of Columbia, Arlington County, Virginia and a few small cities such as Alexandria, Va., Annapolis, Md., Dover, Del., and Atlantic City, N.J., covering an area of 7,000 square miles (of land and Delaware and Chesapeake Bays) and a population of 1,900,000. Of these people 900,000 will receive fallout which will be lethal to almost ~~all~~ exposed personnel (ten hour exposure of 500 r). In close, (6-10 mile radius) of course, there is a compounding of blast, thermal, and radiological effects which will produce casualties, and only the area outside of this region should be considered in evaluating casualties from fallout alone.

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1./ CONTOUR DIMENSIONS EXTRAPOLATED FROM PRELIMINARY DATA AND MUST BE USED WITH EXTREME CAUTION.

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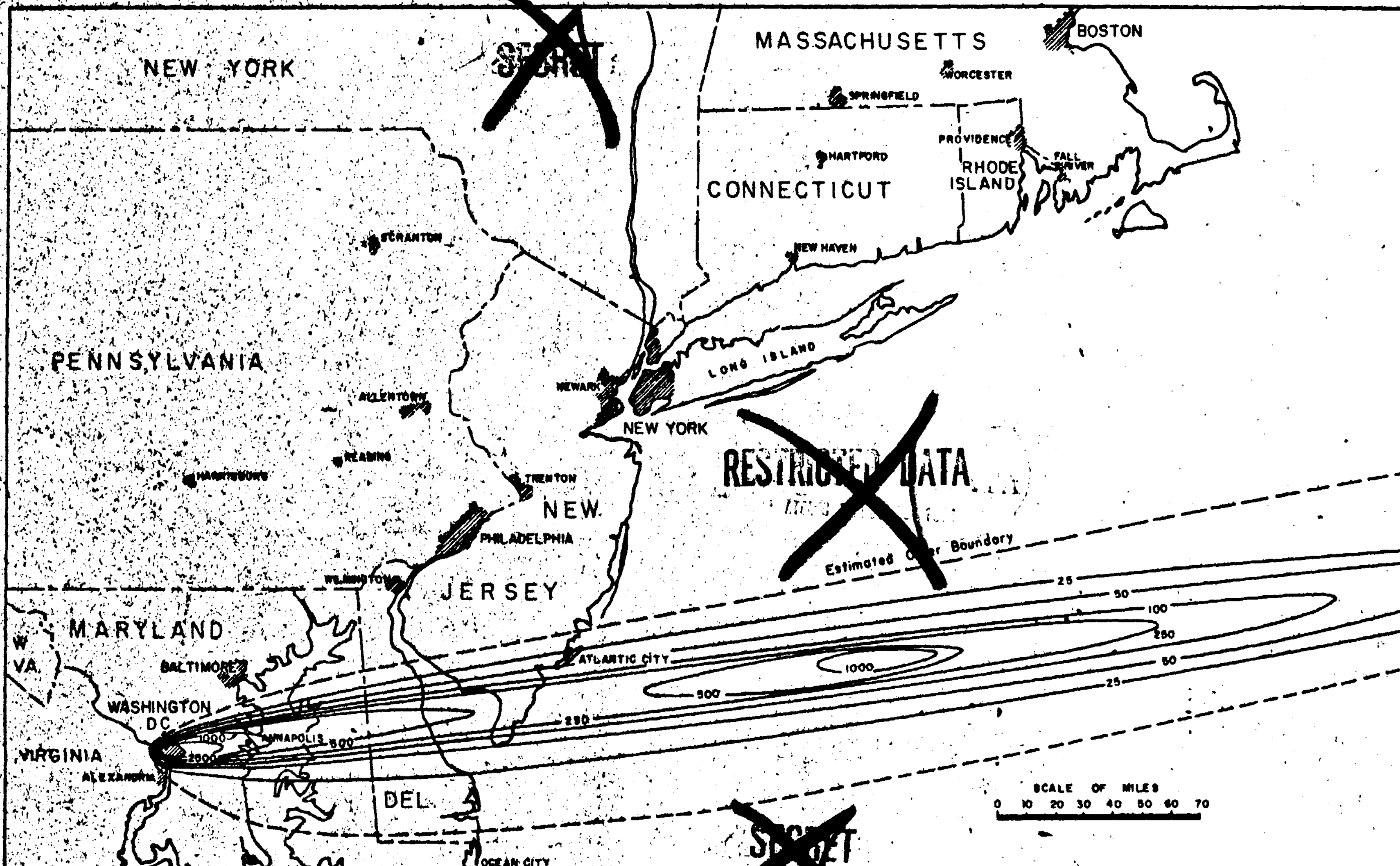

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Figure A.4 Washington, D. C. Ten Hour Exposure Contours Estimated From REDWING Experience. A [redacted] yield surface burst is assumed with a representative winter wind structure. Contour values given in r. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

An examination of Figure 4.4 will show that over 50% of the potential casualty producing region falls in the North Atlantic Ocean. Therefore it is certainly possible to construct examples in which the entire fallout region will encompass populated areas.

It is interesting to speculate on the pattern produced by less representative winds, for example with the pattern moved 30° counterclockwise so that the 250 r ten hour exposure contour extends well past Philadelphia, Pa., New York City, and through Connecticut.

~~The~~ This pattern ~~[illegible]~~ has the following areas:1/

a. A lethal area 200 miles long, 10 miles wide which has a total area of 1700 square miles.

b. A sickness area 350 miles long, 15 miles wide which has a total area of 3800 square miles.

c. An area of biological concern 500 miles long, 30 miles wide, which has a total area of 12,000 square miles.

If the weapon chosen for illustration was of the same total yield but had a small fission yield [redacted] then the pattern would have:

a. A lethal area 25 miles long, 5 miles wide which has a total area of 90 square miles. This area only protrudes slightly beyond the area of major bomb damage.

b. A sickness area 42 miles long (probably in two parts), 14 miles wide, which has a total area of 450 square miles.

1/ Ten hour exposure values are chosen as follows: Lethal - 500 r, sickness - 250 r, biological concern - 50 r. These terms refer to the effect on exposed personnel and do not take shielding into account.

c. An area of biological concern 350 miles long, 15 miles wide, which has a total area of 3,800 square miles.

4.6.4 Southern California Area. Figure 4.5 has been drawn with the ground zero at Santa Monica, California. The pattern takes in nearly all of the Metropolitan Los Angeles area and a number of smaller cities to the East South East. A lethal dosage to exposed personnel would have been delivered to an area inhabited by approximately $4\frac{1}{2}$ million people. In this example, the downwind maximum area fortunately coincides with a desert area North of the Salton Sea and will contribute very little to the casualties. The areas involved are comparable to those discussed in Section 4.6.3. Again the winds have essentially no directional shear and therefore the pattern appears as a very long, narrow area of contamination.

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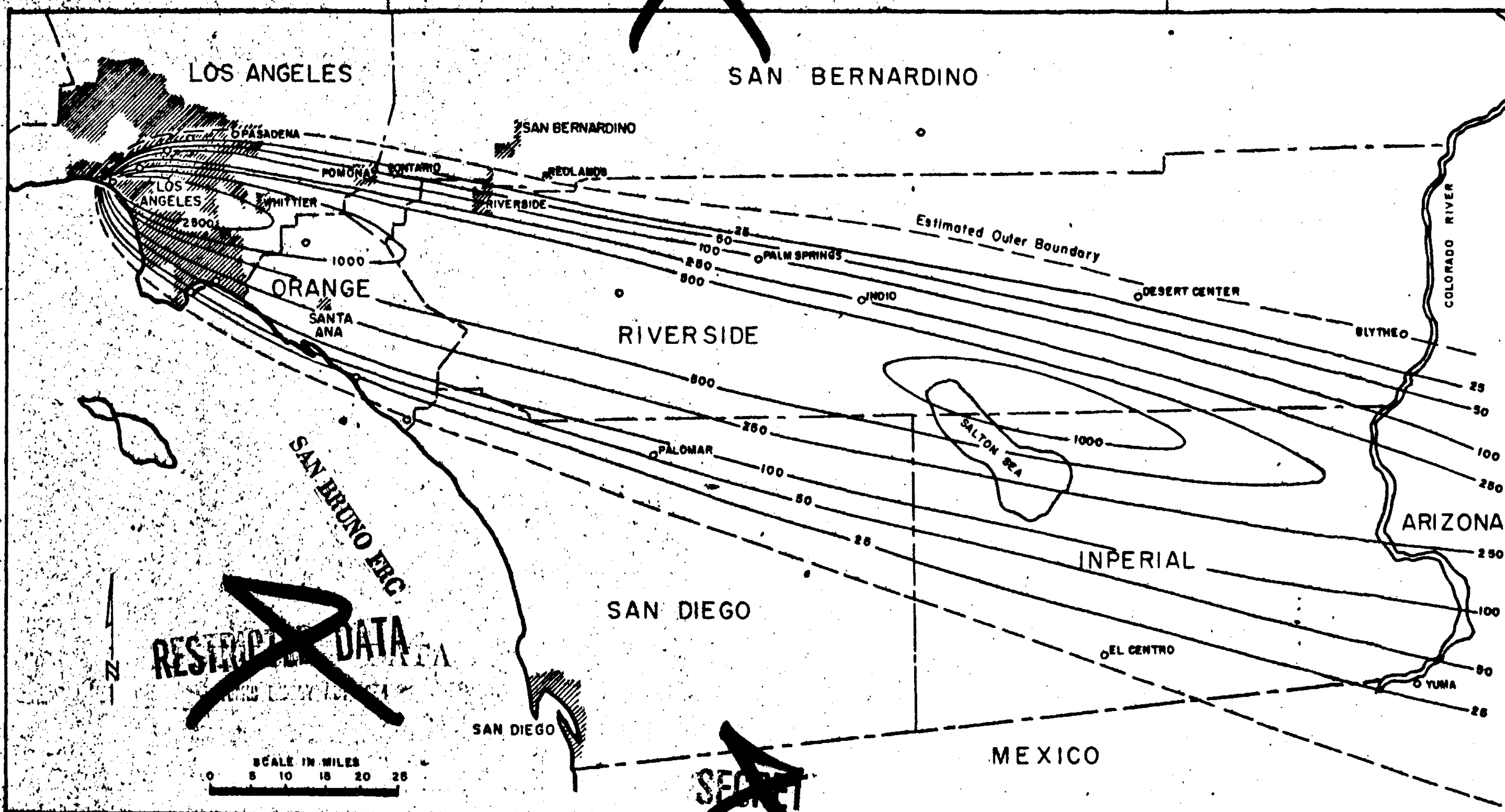

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Figure 4.5 Southern California Ten Hour Exposure Contours Estimated From REDWING Experience. [redacted] surface burst is assumed with a representative winter wind structure. Contour values given in r. EXTRAPOLATED PRELIMINARY DATA. USE WITH CAUTION.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The following general conclusions are considered applicable to the experiments reported in this preliminary report:

1. The fallout program successfully accomplished its mission of documenting the activity levels in the nuclear mushroom and the fallout pattern and collecting fallout materials.

2. The data gathered in the field and subsequent laboratory analyses will supply the material for extensive calculations of fallout prediction models.

3. The concentration of activity in the stabilized nuclear cloud appears to be more dense in a layer near the bottom of the cloud than it is in the upper areas. The most intense contours from a 5 MT surface burst apparently originate from approximately 100 micron diameter particles at 50,000 feet elevation, the region of the base of the cloud.

4. The concentration of activity near 30,000 feet in the stem of the mushroom from a 5 MT burst is less than 3 percent of the concentration in the cloud.

5. The techniques used for land, aerial, and oceanographic survey were successful. Some of these techniques can be applied to military situations.

6. Laboratory analysis of water samples and careful analysis of penetration of activity in the ocean will probably provide the basis for an accurate fission and activation product material balance. An estimate of the amount of active material remaining in the upper atmosphere can be made subsequently.

7. Within the accuracy of this preliminary data, the fallout exposure
at a point equal total detonated under the same conditions
rate produced by a weapon of a given yield is proportional to the fractional radiological yields.

8. The effectiveness of the various fallout survey techniques was greatly enhanced by the coordination provided by the Porgram 2 Control Center.

9. The preliminary data indicates that a [redacted] surface burst would deliver lethal dosages to exposed personnel over an area in excess of 1500 square miles.

10. Exposure rates in excess of 10,000 r/hr at H/1 hour were present in the vicinity of the crater of the Mohawk event.

11. A minimal air burst over water produces no fallout of military significance.

5.2 RECOMMENDATIONS

The only recommendation made on the basis of this preliminary data is to USE CONTOUR INFORMATION WITH CAUTION.

APPENDIX A

SUMMARY OF FALLOUT DOCUMENTATION PROJECTS

PROJECT 2.1

Title: Gamma Exposure Versus Distance, ITR 1310.

PROJECT 2.2

Title: Gamma Exposure Rate Versus Time, ITR 1311.

Project Officer: Mr. Peter Brown.

Agency: Evans Signal Laboratory (ESL).

These projects placed film packs and dosimeters throughout Bikini Atoll and aboard a number of the floating stations. Some of the stations were also instrumented with an ion chamber and recording device to document the radiation exposure rate as a function of time. The initial radiation measurements also made by these projects have not been considered in this report.

PROJECT 2.61

Title: Rocket Determination of the Activity Distribution Within the Stabilized Cloud, ITR 1315.

Project Officer: Mr. Richard R. Soule.

Agency: U.S. Naval Radiological Defense Laboratory (NRDL).

Ion chamber detectors and telemeter transmitters were mounted in the heads of 6½ inch rocket propelled Atmospheric Sounding Projectiles (ASP). These rockets were then flown through the nuclear cloud (and stem) from shots CHEROKEE, ZUNI, NAVAJO, and TEWA and the telemetered exposure rate data was received and recorded at duplicate stations aboard the USS KNUDSON (APD 101) and NAN Island in Bikini Atoll.

PROJECT 2.62

Title: Fallout Contours by Oceanographic Analysis, ITR 1316.

Project Officer: Mr. Feenan D. Jennings.

Agency: Scripps Institution of Oceanography (SIO).

The lagoon and ocean fallout areas were surveyed using an LCU, two destroyer escorts, and the oceanographic survey vessel M/V HORIZON. The surveys included radiation intensity readings in the water near the surface and intensity versus depth profiles. The effect of water currents and the location of the thermocline was determined using data from a pre-CHEROKEE oceanographic survey. This project also was responsible for the mooring and servicing of the skiff array which was located in the deep ocean north of Bikini. The skiffs were instrumented for fallout collection, time of arrival, total exposure, and rate of penetration of the activity in the water measurements. Equipment for the measurement of depth of penetration of activity in ocean water was also placed aboard the YAG 39 and YAG 40.

PROJECT 2.63

Title: Characterization of Fallout, ITR 1317.

Project Officer: Dr. Terry Triffet.

Agency: U. S. Naval Radiological Defense Laboratory (NRDL).

This project provided the majority of collectors and detectors placed aboard the floating collection stations. Complete instrumentation, including incremental and total collectors, exposure rate recorders, and total exposure instruments, were placed aboard the two YAG's, an LST, two YFNB barges moored in Bikini Lagoon, and at the northern

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end of HOW Island in Bikini Atoll. In addition, the YAG-40 had a shielded laboratory in which radiation rate, microscopic, and spectrometric measurements could be performed on the fallout samples as they arrived. Total collectors, total exposure instruments, and time of arrival detectors were placed aboard the deep moored skiffs provided by Project 2.62, three pontoon rafts in Bikini Lagoon, and at Sites GEORGE, WILLIAM, and CHARLIE in Bikini Atoll.

PROJECT 2.64

Title: Fallout Location and Delineation By Aerial Survey, ITR 1218.

Project Officer: Mr. Robert T. Graveson

Agency: New York Operations Office, U. S. Atomic Energy Commission (NYOO/AEC)

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P2V aircraft were instrumented to measure gamma exposure rate and were flown over the ocean fallout areas to perform as rapid and complete a survey as possible. Calibration flights with a spectrometer in a helicopter and radiochemical analysis of water samples were performed to reduce the data to absolute intensities. Instrumentation for cross correlation was placed on the YAG-39 and YAG-40.

PROJECT 2.65

Title: Land Fallout Studies, ITR 1219.

Project Officer: Mr. Manfred Morgenthau.

Agency: Chemical Warfare Laboratories, Army Chemical Center (CWL/ACC).

This project provided the primary land fallout collecting stations and instrumented a number of islands in Bikini Atoll with total and incremental collectors. A small number of stations were instrumented for

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one "small" shot at Eniwetok. One remote collector was located at Rongerik Atoll, 130 miles southeast of Bikini. The samples from these collectors were subjected to radiophysical and radiochemical analyses to determine specific activity, particle sizes, distribution of activity on and within the particles, chemical fractionation, etc. Some instrumentation was placed on a number of the floating stations for correlation purposes. This project also made gamma ~~dose~~ exposure rate measurements on islands in both the Bikini and Eniwetok Atolls by means of a detector which was lowered to the ground from a helicopter.

PROJECT 2.66

Title: Early Cloud Penetration, ITR 1320.

Project Officer: Colonel Ernest A. Pinson, USAF.

Agency: Air Force Special Weapons Center, Air Research and Development Command (SWC/ARDC).

B57-B aircraft, completely instrumented fo exposure rate and total exposure were flown for brief periods within the nuclear clouds to obtain personnel exposure and aircraft contamination data.

PROJECT 2.71 BEST AVAILABLE COPY

Title: Ship Shielding Studies, ITR 1321.

Project Officer: Mr. Heinz Rimmert.

Agency: U. S. Naval Radiological Defense Laboratory (NRDL)

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This project, while basically intended for ship shielding studies, provided gamma ~~dose~~ exposure rate information in conjunction with Project 2.63 on the ships in the region of fallout.

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APPENDIX B

CONSTRUCTION OF PARTICLE FALL PLOTS

The construction of a particle fall plot begins with the assumption of a vertical line source of particles above ground zero. For the purposes of the Program 2 operational plots and those presented in this report constructions were made for four particle sizes only: 75, 100, 200, and 350 microns.

The wind velocity observed at a 5,000 feet interval was assumed to represent the average wind throughout the 5,000 feet layer centered at that height. Therefore the wind velocity, multiplied by the time a particular particle takes to fall through a 5,000 feet layer, gives the horizontal displacement of the particle. The particle fall times were calculated from aerodynamic equations, choosing a representative air density and viscosity profile for the Marshall Islands atmosphere.

In constructing a pattern which neglects space and time variation of the wind profile, the static hodograph is most convenient. It can be drawn simply by placing the displacement vectors end to end commencing with the lowest altitude. The resultant line represents the locus along which the given size particles from all altitudes arrive. The same procedure is repeated for each of the particle sizes. The locus of all particles from a given altitude can then be sketched through the individual points.

A time varying analysis necessitates more labor. Since the winds at a particular altitude change as particles from different altitudes above arrive, the simple hodograph cannot be used. The procedure of constructing the actual projected trajectories must be followed. This procedure involves constructing a complete trajectory for each particle size from each altitude.

The space variation can also be included in this analysis.

The particle fall plots in this report have been constructed including time and space variations whenever these had appreciable effects on the pattern.

For the purposes of fallout prediction, particularly as applied to the problem of positioning ships from the Program 2 Control Center (see Section 2.3.6), the predicted winds were necessarily utilized. Since the predicted time variation is even more uncertain than the predicted zero time wind profile, the former was not included in the initial analysis. Shot time and later wind observations were used in a time varying analysis to reposition fallout collecting ships until they received fallout and to direct the motion of survey vehicles so as to avoid receiving direct fallout.

The positions of the fallout collecting ships were determined by assuming that the majority of the activity was in the lower third of the initial cloud. The limit of interest is given by the 75 micron particles since these fall at late times over very large areas and have only a small fraction of the total activity associated with them. The times of arrival and cessation of fallout were calculated from the constructed pattern and the particle fall time data, assuming the effective radiological cloud to have the dimensions of the visible cloud except when considering the larger particles. One thousand micron diameter particles were assumed to be present in only the inner 10 percent and 500 micron particles in 50 percent of the cloud. This assumption modified the close-in fallout to correspond to actual observations at previous operations.

It was not necessary in any of this work to associate a specific activity concentration with each region of the cloud and particle size and hence to determine the actual radiation pattern. It is an aim of this report to present data out of which such associations can be made.

APPENDIX C

RADIATION CONVERSION FACTORS

For the purposes of the calculations in this report, certain conversion factors were needed to reduce radiation data to a common basis. The factors related to the conversion of gamma exposure rates between different distances from the source have been calculated in Reference 31 and are summarized in Table C1. The factors relating the observed exposure rates to the density of active sources have also been derived in Reference 31 and are summarized in Table C2.

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TABLE C1 HEIGHT CONVERSION FACTORS FOR GAMMA EXPOSURE

	Height Above Surface in Feet						
	10	25	50	100	250	500	1000
Factor to convert reading above land to height of 3 ft	1.4	1.7	2.2	3.1	5.2	12	46
Factor to convert reading above water to height of 3 ft	1.0	1.1	1.1	1.2	1.5	2.2	6.2

Note: For RadSafe aerial readings an additional factor of 1.5 was found to be necessary to normalize readings to Project 2.65 helicopter probe readings.

TABLE C2 CONVERSION OF ACTIVITY DENSITY TO EXPOSURE RATE

Volume density of activity in water............	1 curie/m^3
Exposure rate reading in water...............	0.6 r/hr
Exposure rate reading 3 ft above water.......	0.3 r/hr
Volume density of activity in air at STP.......	1 curie/m^3
Exposure rate reading in air.................	1200 r/hr
Surface density of activity on land............	1 curie/m^2
Exposure rate at 3 ft above land..............	6 r/hr

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APPENDIX D

INTERPRETATION OF EXPOSURE RATE VERSUS AREA PLOT

A plot of converted H+1 hour exposure rates versus area of contour ~~on~~ ~~contour~~ on log-log paper is a particularly useful tool for analyzing the fraction of the weapon's fission products which has been deposited in the local fallout pattern. It appears that such a plot can usually be fitted by a straight line of slope -1 over a portion of the data, with the extreme points falling below this line. In particular the predicted values from Reference 29 fall on such a line for more than a factor of 100 in area or exposure rate. This line on log-log paper represents a reciprocal relation between exposure rate and area. It has a particular significance in terms of the integral of the exposure rate over the area. For this reciprocal relationship the value contributed to the integral by any particular range of exposure rates is the same as that contributed by another range having the same ratio of upper to lower values. Therefore, most of the material deposited will be associated with the part of the curve that fits the line of slope -1, and a smaller portion with the points that fall below this line. A crude estimate of the radiological yield observed can thus be calculated by multiplying the area = 1 intercept by the natural logarithm of the ratio of the upper and lower area values for which the straight line makes a reasonable fit to the data. For example, in Figure 4.1 the extrapolated 5 MT predicted straight line section has an intercept of approximately 7.5 X 10^5 r/hr at an area of 1 square mile. The straight line fits the prediction over areas covering a factor of 500. Therefore, the integrated material corresponds to

$$7.5 \times 10^5 \log_e 500 = 4.7 \times 10^6 \text{ mi}^2 \text{ r/hr}.$$

Assuming a conversion factor of 1200 mi^2 r/hr per KT (very uncertain; assumes 300 megacuries at H+1 per KT), the material accounted for represents 3.9 MT or 78 percent of the total yield.

APPENDIX E

FRACTION OF SHOT ACTIVITY IN FALLOUT

For the purpose of checking a number of parameters, the quantity of radioactive material in the fallout areas were calculated and compared with the activity resulting from the fission yield of the bomb. The normalization factor used was 4000 mi^2 r/hr per KT of fission yield. This factor was derived by examining a draft of the Operation CASTLE Project 2.7 report (Reference 32).

The total activity encompassed by the CASTLE Shot 5 contours was normalized to 10% of the weapon's fission yield which was determined to be inside these contours by an absolute beta counting technique. The percent of the total activity for REDWING shots is presented in Table E1. The percentage of activity values as given, must be accepted with reservation since the errors and uncertainties in the decay exponents and normalization factors can easily amount to factors of 2.

[redacted]

TABLE F1

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* Based on 4000 mi^2 r/hr per KT.

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REFERENCES

1. Ballou, N.E. and Bunney, L.R.; Nature and Distribution of Residual Contamination II, Project 2.6c-2, Operation JANGLE, WT-397, June 1952, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

2. Maxwell, C.R.; Nature and Distribution of Residual Contamination I, Project 2.6c-1, Operation JANGLE, WT-386, June 1952, National Institutes of Health, Bethesda, Maryland, SECRET, RESTRICTED DATA.

3. Robbins, Charles; Airborne Particle Studies, Project 2.5a-1, Operation JANGLE, WT-394, July 1952, Army Chemical Center, Maryland, SECRET, RESTRICTED DATA.

4. Summary Report, Weapons Effects Tests, Operation JANGLE, WT-414, November 1952, Armed Forces Special Weapons Project, Washington, D.C., SECRET, RESTRICTED DATA.

BEST AVAILABLE COPY

5. Poppoff, I. G.,; Fallout Studies, Project 2.5a-2, Operation JANGLE, WT-395, U. S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

6. Laurino, R.K. and Poppoff, I.G.; Contamination Patterns at Operation JANGLE, USNRDL-399, April 1953, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

7. Johnson, J., Monitor Survey of Ground Contamination ; ~~Gamma Radiation Measurements~~, Project 2.1d ~~2.1a-1~~, WT-380 ~~WT-379~~, Operation JANGLE, Armed Forces Special Weapons Project, Washington, D.C.

8. Forbes, M.B.; Total Gamma Radiation Dosage, Project 2.3-1, WT-331, Operation JANGLE, Evans Signal Laboratory, Fort Monmouth, New Jersey, SECRET, RESTRICTED DATA.

SAN BRUNO FRC

216

SECRET

RESTRICTED DATA

ATOMIC ENERGY ACT 1954

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SECRET

9. Costrell, L.; Gamma Radiation as a Function of Time and Distance, Project 2.1a, WT-329, Operation JANGLE, National Bureau of Standards, Washington, D.C., SECRET, RESTRICTED DATA.

10. Armed Forces Special Weapons Project, Fallout Symposium, January 1955, Armed Forces Special Weapons Project, Washington, D.C., SECRET, RESTRICTED DATA.

11. Greenfield, S.M., et al; Transport and Early Deposition of Radioactive Debris From Atomic Explosions, R-265-AEC, July 1954, The Rand Corporation, Santa Monica, California, SECRET, RESTRICTED DATA.

12. Iugiojian, H.M.; Radioactive Fallout From Atomic Bombs, November 1953, Air Research and Development Command, Baltimore, Maryland, SECRET, RESTRICTED DATA.

13. Maxwell, R.; Radiochemical Studies of Large Particles, Project 2.5a-3, WT-333, Operation JANGLE, Army Medical Center, Washington, D.C., SECRET, RESTRICTED DATA.

14. Adams, C.E., et al; The Nature of Individual Radioactive Particles I. Surface and Underground ABD Particles from Operation JANGLE, USNRDL-374, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

15. Cadle, R. D.; The Effects of Soil, Yield, Scaled Depth on Contamination from Atomic Bombs, SRI Project CU-641, June 29, 1953, Stanford Research Institute, Palo Alto, California, SECRET, RESTRICTED DATA.

16. Tompkins, R. C. and Krey, P. W.; Radiochemical Studies in Size Graded Fallout and Filter Samples from Operation JANGLE, CRLIR-170, August 7, 1952, Army Chemical Center, Maryland, SECRET, RESTRICTED DATA.

~~SECRET~~

17. Bouton, Edwin H., et al; Fallout and Cloud Particle Studies, Project 5.4b, WT-617, Operation IVY, June 1953, Army Chemical Center, Maryland, SECRET, RESTRICTED DATA.

18. Heidt, W.B., Jr., et al; Nature, Intensity, and Distribution of Fallout from Mike Shot, Project 5.4a, WT-615, Operation IVY, April 1953, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

19. Malik, John S.; Gamma Radiation Versus Time, Projects 5.1 and 5.2, WT-634, Operation IVY, February 1954, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, SECRET, RESTRICTED DATA.

20. Tompkins, E.R. and Werner, L.B.; Chemical, Physical, and Radiochemical Characteristics of the Contaminant, Project 2.6a, WT-917, Operation CASTLE, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

21. Tompkins, R. C. and Krey, Philip W.; Radiochemical Analysis of Fallout, Project 2.6b, Operation CASTLE, September 1954, Army Chemical Center, Maryland, SECRET, RESTRICTED DATA.

22. Stetson, R. T., et al; Distribution and Intensity of Fallout, Project 2.5a, WT-915, January 1956, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

23. Armed Forces Special Weapons Project, Summary Report of the Commander, Task Unit 13, Operation CASTLE, June 1954, Armed Forces Special Weapons Project, Washington, D. C., SECRET, RESTRICTED DATA.

24. Brown, Peter and ~~Gage~~ Oake, Gerald; Gamma Rate Versus Time, Project 2.2, ITR-913, Operation CASTLE, May 1954, Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey, SECRET, RESTRICTED DATA.

~~SECRET~~

~~RESTRICTED DATA~~

218

25. Dempsey, Robert, et al; Total Gamma Exposure Measurement, Project [illegible], Signal Corps Engineering [illegible],
Fort Monmouth, New Jersey, SECRET, RESTRICTED DATA.

26. Wilsey, E.F., et al; Fallout Studies, Project 2.5b, ITR-916, Operation CASTLE, Army Chemical Center, Maryland, SECRET, RESTRICTED DATA.

27. Folson, T., et al; Study of Radiation Fallout by Oceanographic Method, Project 2.7, ITR-935, Scripps Institution of Oceanography, La Jolla, California, SECRET, RESTRICTED DATA.

28. Stetson, R. L., et al; Distribution and Intensity of Fallout, Project 2.5a, Operation CASTLE, WT-915, Page 21, U.S. Naval Radiological Defense Laboratory, San Francisco, California, SECRET, RESTRICTED DATA.

29. Armed Forces Special Weapons Project, Capabilities of Atomic Weapons, October 1953, Page 96 ff, Armed Forces Special Weapons Project, Washington, D. C., SECRET, RESTRICTED DATA.

30. USNRDL letter, 3-930-0335 ERT:as, of 2 August 1956, to Director, Program 2, CONFIDENTIAL.

31. Van Lint, V.A.J., Gamma Rays from Plane and Volume Source Distributions, Operation REDWING, ITR-1345, Program 2, CONFIDENTIAL, RESTRICTED DATA.

32 Folsom, T and Werner, L.B. Project 2.7, Operation CASTLE, WT- SECRET, RESTRICTED DATA

TOP SECRET

CLOSED

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File Number
59 Part 2.
Previous Reference Part 1.
For Cross References see inside of Cover

Date of Registration ~~9.45~~ 11.10.46.

THERMO-NUCLEAR WEAPONS.
POLICY AND RESEARCH.

Referred to	Date	Referred to	Date	Referred to	Date
Pa. [illegible]	20 MAY 1960				
Mrs. Grimble	10.12.71				
PA	13.12.71				
Mr. Cheatle	20.8.76				

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J.F.G./55/26

MR. STRATH 3/3823.

Information for the Public on Hydrogen Warfare

1. We have already appreciated that information concerning hydrogen warfare must be handed to the public with forethought and care. We have also appreciated that the public must eventually have the full information concerning its hazards and the means of protection from them.

2. At present, time is on our side; but not very much. Despite the information already given to the American public, the British public has remained calm, perhaps under the steadying influence of the White Paper; there has been remarkably little wash from its wake. The recent debate on genetics, however, may stir up controversy and a demand for fuller information.

3. A potential enemy could use the frightening nature and enormous power of this weapon to great effect on an uninformed and ignorant public. The modern edition of sabre rattling has already certainly been used once in the overt contradiction between the U.S.S.R. and the U.S.A. as to which has the greater stock of nuclear weapons. A Scandinavian gentleman was ordered out of the country yesterday for exhibiting horror pictures of the atomic bursts on Japan; three Japanese ladies are touring the Midlands describing these horrors. One wonders how much covert activity on this subject is being used on our people by the Russians.

4. The previous Government created a Governmental Organisation for the stimulation, planning and co-ordination of anti-Communist activity. An Anti-Communist (Ministerial) Committee was formed with A.C. Official Committees for overseas and home. Under the present Government the A.C. (Ministerial) Committee has never sat; the A.C. (Overseas) Official Committee has been kept just alive; the A.C. (Home) Official Committee had not met for a year before its meeting last autumn when it decided to double its frequency of sitting.

Quite separate from, and not apparently linked with, this psychological warfare organisation is a sub-Committee of the Civil Defence Joint Planning Staff under Home Office Chairmanship. Its Terms of Reference are to consider the psychological and sociological aspects of weapons of mass destruction on the public. The sub-Committee has not met for over a year.

5. There is little doubt that the menace of hydrogen warfare will be a major factor in the war of nerves, and one easily exploited by the Communists. The morale of our people, and their will to face the threat, may well be undermined unless special steps are taken to prevent it.

E.P.

6. I suggest, therefore, that consideration be given to reactivating this Governmental organisation, especially the A.C. (Home) Official Committee and its Ministerial Committee, to provide the necessary high level and professional guidance on this problem of considerable psychological importance.

J. F. Godwin.

Central War Plans Secretariat,
Great George Street, S.W.1.

23rd March, 1955.

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Brook

L.R. Pl. circulate to H.D.C. + send [illegible] to Sir N. Brook [illegible]. WS 22/3

Pl. circulate to members of H.D.C. for early comment. And let me have a TOP SECRET copy so that I may proceed as at x/. I wd. like to talk to you about y/. B. 22/3.

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SIR NORMAN BROOK

Both answered 'y' with Sir N. Brook. Agreed that an effort be made to get the report taken by the Defence Cttee immediately after Easter. WS 22/3

I submit herewith a draft paper from the Home Defence Committee summarising the main points which emerged from their consideration of the Report on the Defence Implications of Fall-out from a Hydrogen Bomb.

If momentum is to be maintained in the subsequent planning operations by Departments, it is important that the

y | report and the attached draft paper should be considered by the Defence Committee as quickly as possible after the Minister of Defence has held his restricted meeting of Ministers. It would be very helpful, therefore, if arrangements could be made for both documents to be circulated for discussion by the Defence Committee before the Easter Recess.

File

Although it may not be possible to clear the attached draft with the other members of the Home Defence Committee before the Minister of Defence's meeting on Thursday takes place, you may

x | wish to send an advance copy to the Minister of Defence for the information of that meeting.

WS.

(W. STRATH)

22nd March 1955

THE DEFENCE IMPLICATIONS OF FALL-OUT FROM A HYDROGEN BOMB

Note by the Home Defence Committee

We have considered the report prepared at the request of Ministers by a group of officials [H.D.C.(55)3] on the defence implications of fall-out from a hydrogen bomb. It has also been examined by the Heads of Departments concerned. Both we and they endorse in substance ~~the~~ its conclusions and recommendations; the main comments made upon it are briefly recorded below.

2. Strategic Assumptions

(a) The Chiefs of Staff consider that any future war in which the United Kingdom itself was attacked would involve the use of the hydrogen bomb. It follows, therefore, that such home defence preparations as are relevant to war fought with conventional or atomic weapons only should be discontinued. This would secure some financial saving to offset the heavy cost of precautions against a hydrogen bomb attack.

(b) We cannot tell with any certainty how much warning the United Kingdom would get before an attack. We consider, however, that, solely for planning purposes, Departments should continue to assume that the Government would be able to detect a deterioration in the international situation some six months before war came and would know say seven days in advance that an attack on this country was inevitable. These assumptions are necessary to enable certain plans to be prepared, for example on evacuation, which depend for their validity on a period of warning. But Departments should be reminded that there can be no assurance that either assumption would be realised.

(c) Whether or not the enemy was able to repeat his initial assault, the devastation would be on such a scale that the United Kingdom could not be used as a main supply base for such operations as continued after the opening phase. Plans for the building up of industrial war potential in this country on the basis that it could be used to support long drawn out hostilities after global war had broken out are, therefore, no longer realistic.

3. Publicity

The Government, we suggest, should not seek to impress the public with the dangers of thermo-nuclear war until they can tell them at the

/same time

same time what measures of protection can be taken. Further information on the effects of hydrogen bombing, beyond that already given in the Statement on Defence, should, however, be released as necessary where it is essential for the adequate preparation of defence plans.

4. Evacuation and Shelter

(a) We feel that the Government's eventual plans on ~~the~~ evacuation and shelter would command wider public support if presented with the authority of an independent Committee, as was done before the last war when the Anderson Committee reported on evacuation in 1938. But we do not advocate the establishment of such a body until the Government's plans have been more fully elaborated.

(b) The Royal Air Force are planning to disperse their strategic bomber force over some seventy airfields in this country and it is intended to give widespread publicity to this dispersal. It will not therefore be necessary, as suggested in paragraph 81(ii) of the report, in preparing the evacuation scheme to regard the areas of the main bomber bases as unsuitable for the reception of evacuees because they are likely enemy targets.

5. Machinery of Control

Under the conditions envisaged in the report the risk must be accepted that the central machinery of Government might be put out of action for a period. Preparations should therefore be made for regional headquarters to operate independently of the centre during that time. Plans must also be made to restore central Government at the earliest possible moment.

6. Oil

We wish to emphasise the importance of oil as a key factor in the survival period and the need to provide in peacetime a sufficient stockpile, suitably dispersed, to cover the country's needs for some months after an attack. Many of the measures necessary to national survival as seen in the report, such as the movement of civil defence and military forces and the distribution of food, would be impossible without adequate supplies of oil.

7. Expenditure on Defence

All defence preparations, whether the responsibility of Service or Civil Departments, should in future be considered as interdependent parts

/of one

of one whole. The sum of financial and other resources available for defence should therefore be apportioned between the various measures as integral parts of a co-ördinated programme designed to hold a balance between active and passive defence as the circumstances of the time require.

8. Conclusion

We recommend that authority should be given for defence preparations to be revised along the lines recommended in the report as amplified by the points made in this note. This would give Departments a basis on which to produce specific plans which would be submitted for detailed approval as necessary.

22nd March 1955

Fall-out

Main Points Raised at Meeting
on 16th March

1. Nature of Attack. Can Departments be directed to plan on the assumption that, in a war involving attack on U.K., thermo-nuclear weapons are certain to be used? In other words, can they exclude the possibility of an attack with conventional or atomic weapons only?

2. Warning Period. Can we continue to assume, for planning purposes, (i) that the Government will mark a deterioration in the international situation six months before the outbreak of war; and (ii) that a further Alert will be given 7 days before we are attacked?

3. Expenditure. Our new defence plans should not assume a mounting level of expenditure on defence.

4. Research. Irrespective of agreements for the exchange of technical information on atomic energy, we should press the United States to give us the results of research into protective measures - e.g., effects of radio-activity on agriculture, types of shelter etc.

5. Evacuation and Shelter. It will be easier to win public acceptance of the Government's eventual plans if these are presented with the authority of an independent Committee - c.f. Anderson Committee of 1938.

6. Publicity. In general, the development of publicity should go hand in hand with the development of plans. We should not seek to impress the public with the dangers of thermo-nuclear war until we can tell them at the same time what measures of protection can be taken.

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7. Aftermath. Would it be possible for the Chiefs of Staff to give some further guidance about the likely development of war - or peace - after the initial assault? Is it assumed that, if U.K. survives, it will be able to make any contribution towards continuance of the war? Is it assumed that war will continue? Are we really to prepare for a struggle which will be settled, one way or the other, in a matter of days?

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SIR RICHARD POWELL
Ministry of Defence

Strath Group Report

The printed draft of the Strath Group Report will, as arranged, be circulated tomorrow. Mr. Strath has asked me to draw your attention to some additional sentences which he has inserted in the first paragraph of Section XIII (The Armed Forces and Defence Production) to deal with the role of reserves in global war.

There is one other point I might mention. In considering plans for the evacuation of the revised priority classes, you asked whether "adolescents below the age of eighteen" should refer only to those who are still at school. I gather from the Home Office that existing plans in fact cover those below the age of eighteen whether they are still at school or not. We have therefore made no addition to the draft passage which sets out the composition of the revised priority classes.

(P.L. BROCK)

3rd March, 1955

File 5.9

Mr Strath

NO. 6086

3/3/7 14.

MR. GODFREY

Copy to: Mr. Hanna

QUESTION: Mr. Anthony Greenwood: To ask the Prime Minister, if he will arrange for the publication of a White Paper setting out such information as Her Majesty's Government possesses about the effects of Hydrogen bomb and other forms of nuclear warfare.

I suggest the following answer. I have discussed it with Mr. Strath and with Mr. Dean of the Foreign Office.

"I am not in a position to add usefully to the information given in the Statement on Defence for 1955 and in the recent report by the United States Atomic Energy Commission, copies of which I am having placed in the library of the House. As the Statement on Defence indicates, Her Majesty's Government will make further statements from time to time as their views develop. I shall be dealing with the subject of thermonuclear warfare in the Defence Debate next week."

Background Information

If the term "nuclear warfare" were interpreted in its widest sense, a White Paper of the kind for which Mr. Greenwood asks would have to begin with the reports on the atomic bombing of Hiroshima and Nagasaki in 1945 and contain all the information on atomic weapons and their use

which has since been released, principally by the United States Government.

On a narrower interpretation, which would confine the White Paper to information on thermonuclear weapons, the only authentic information in the possession of Her Majesty's Government is that which has been officially released by the U.S. Government. (Such "under-the-counter" information as we have received has been in the main no more than an anticipation of these official releases, and could not in any event be quoted publicly). The principal statements are those released by the U.S. Atomic Energy Commission about the explosions at Eniwetok on 31st October 1952 and at Bikini on 1st March 1954, and the report on the effects of high-yield nuclear explosions which was released on 15th February, 1955.

In a debate on Civil Defence in the House of Commons on 5th July 1954, the then Home Secretary repeated much of the information about the Bikini explosion which had been released by the U.S. Atomic Energy Commission. There have been other general references from time to time in debates or in answers to questions. There would be little point in collecting all these together and putting them into a White Paper.

The only information which H.M. Government has itself published on these subjects is contained in the Statements on Defence for 1954 and 1955. The new Statement, which will be debated next week in the House of Commons, is by far the more important, and contains the first considered expression of opinion by H.M.G. on thermonuclear weapons and their effects.

Dictated by Sir R. Powell
[illegible]

23rd February, 1955.

Times.

18th February 1955.

BRITAIN TO MAKE THE HYDROGEN BOMB

DEFENCE STATEMENT ON "DUTY TO PROCEED"

CONTRIBUTION TO WAR DETERRENT

Britain is to begin producing the hydrogen bomb. In the annual Statement on Defence, presented to Parliament yesterday, the Government announce that, after fully considering all the implications, they think it their duty to take this step as a deterrent to war.

In a review of the country's other defence needs, the statement makes these points :—

NUCLEAR WEAPONS.—Stocks are steadily growing. Work to increase their variety and power is going on.

NAVY'S ROLE.—A start is to be made on building a new class of guided weapon ship, to replace older cruisers. Heavy carriers also will augment the allied striking fleet. A better equipped Active Fleet and a smaller but better prepared Reserve Fleet are planned.

V-BOMBER FORCE.—The primary task of the R.A.F. is to build this force to the highest possible state of preparedness.

STRATEGIC RESERVE.—Reduced commitments oversea make it possible to rebuild a strategic reserve of land forces at home.

MOBILE DEFENCE CORPS.—To defend the home base, this corps will be formed as part of the Army and R.A.F. reserve forces.

CIVIL DEFENCE.—The advent of the hydrogen bomb calls for a new approach. The Mobile Defence Corps, trained in fire-fighting and rescue work, will be a vital link between the local civil defence and the armed forces.

The statement says that we must not flinch from the necessity to use nuclear weapons, but adds that realization of the magnitude of disaster which war would bring may generate a will to peace.

NEW PROBLEMS IN POLICY

COURAGE NEEDED FOR SOLUTION

By Our Political Correspondent

The Government have decided that this country must begin the development and production of the hydrogen bomb. This momentous decision was made known in the annual Statement on Defence, presented to Parliament yesterday.

The opening paragraph of the White Paper emphasizes that the emergence of the thermo-nuclear bomb overshadowed all else in 1954 and that this has posed new and revolutionary problems in defence policy that require courage and imagination for their solution. Reference is made to the American experimental explosions of thermo-nuclear weapons and the paper says that "there are no technical or scientific limitations on the production of nuclear weapons still more devastating."

"The United States Government," it continues, "have announced that they are proceeding with the full-scale production of thermo-nuclear weapons. The Soviet Government are clearly following the same policy; though we cannot tell when they will have thermo-nuclear weapons available for operational use.

"The United Kingdom also has the ability to produce such weapons. After fully considering all the implications of this step the Government have thought it their duty to proceed with their development and production."

"THE ONLY MEANS"

Reference is made to the unprecedented destruction, both human and material, which the use of thermo-nuclear weapons would cause in war, but the paper emphasizes that the use of nuclear weapons is the only means by which the massive preponderance of the Communist world in conventional land forces can be countered in the event of war.

"We must therefore contribute to the deterrent and to our own defence by building up our own stock of nuclear weapons of all types and by developing the most up to date means of delivery," the paper goes on. "We must, moreover, in making our plans for dealing with aggression against our alliance, not flinch from the necessity to use these weapons. For in the knowledge of our resolve lies the best hope, and it is a real hope, that it may never be put to the test."

WAR RISK REDUCED BY WEAPON

GOVERNMENT'S VIEW

The paper suggests that realization of the magnitude of disaster which war would bring "may bring home to people in all lands the consequences of war and generate a compelling will to peace, strong enough to enforce itself on the most arbitrary of rulers. That is the first implication of the nuclear weapon. It is one not of despair but of hope."

The Government's considered view is that the powerful deterrent of the nuclear weapon in the hands of the free world—which has a marked superiority both in the weapon itself and in the means of delivering it—has "significantly reduced the risk of war on a major scale." Emphasis is laid on the Government's intention to continue to strive for a practical scheme of disarmament as a contribution to the avoidance of war.

Their ultimate aim is abolition of the use, possession, and manufacture not only of all nuclear weapons but also of other weapons of mass destruction, together with simultaneous major reductions of conventional armaments and armed forces to agreed levels which would redress the present Communist superiority.

£43M. U.S. AID

The total expenditure to be incurred on defence in 1955-56 is estimated at £1,537m. This will be reduced by £43m. in American aid to a net figure of £1,494m. chargeable to the Budget—which is £60m. less than the original estimate of net expenditure on defence in the present financial year. The original net defence budget of £1,554m. for 1954-55 however, "will be considerably underspent, mainly because of development difficulties associated with the newer equipments and also because of unavoidable delays in works services."

The proposed expenditure on the three Services next year shows that while £3m. more will be spent on the R.A.F. the Army will receive £77m. less and the Navy £20m. less than in the present year. The following table shows how the gross expenditure on defence—not allowing for receipts from American aid—will be apportioned in 1955-56, and the comparable estimates for the present financial year:—

NOT ALLOWING FOR RECEIPTS FROM AMERICAN AID

(£ million)

—	Estimate, 1954-55	Estimate, 1955-56
Admiralty	367·0	347·0
War Office	561·0	484·0
Air Ministry ..	537·0	540·4
Ministry of Supply ..	151·0	147·5
Ministry of Defence	23·9	18·3
	1,639·9	1,537·2

A further reduction is estimated in the number of male regular recruits during the years 1954-55 and 1955-56. The figure for

Manchester Guardian.
18th February, 1955.

BRITAIN TO MAKE THE H-BOMB

Deterrent Now—but Ultimate Aim is Disarmament

MOBILE DEFENCE CORPS

FROM OUR POLITICAL CORRESPONDENT

Britain is to develop and produce thermo-nuclear weapons, which include the hydrogen bomb. The Government declares in the "Statement on Defence, 1955," which was published last night, that its immediate duty and policy are to build up our own forces, in conjunction with those of our allies, into the most powerful deterrent we can achieve, and by this means to work for peace through strength. "Thus we shall hope to obtain real disarmament and relaxation of tension," it adds. "But we must also so equip and train our forces, and so organise the country, as to enable us to survive and to defeat the enemy if all our efforts for peace should fail."

The Government tries in this White Paper to tell the public, in one paragraph, what the effects of an attack by thermo-nuclear weapons would be. The conclusion is that it would be a struggle for survival of the grimmest kind. If all the world realised this, a compelling will to peace might be generated "strong enough to enforce itself on the most arbitrary of rulers."

"That is the first implication of the nuclear weapon. It is not one of despair but of hope. In the hands of the free world, which at present has a marked superiority both in the weapon itself and in the means of delivering it, and which has no thought of aggression, it is a most powerful deterrent. In the Government's view this deterrent has significantly reduced the risk of war on a major scale."

The search for a practical scheme of disarmament will continue. The Government's ultimate aim is: "Abolition of the use, possession, and manufacture not only of all nuclear weapons, but also of other weapons of mass destruction, together with simultaneous major reductions of conventional armaments and armed forces to agreed levels which would redress the present Communist superiority."

Need for Safeguards

The time-table would have to be agreed, and the provision of machinery to supervise and enforce agreed prohibitions and reductions would be essential. If the free world were to disarm without such safeguards, the White Paper says, it would incur a double risk: the threat of conventional forces which it could not hope to match; and the danger that such forces might be supported by nuclear weapons made secretly because there had been no adequate control.

Preparations for defence against the risk of thermonuclear war will not apparently produce any startling changes in 1955-6, except the decision to start building up a mobile defence corps for home duties which, within the next three or four years, should comprise 48 reserve battalions of at least six hundred men each. But there is to be no reduction in the period of whole-time National Service; no great change in the conventional forces which the Government considers to be necessary to hold the eastern frontier of "free Europe," to deal with sporadic outbreaks in the cold war, to assist Colonial governments if in need, and to provide a strategic reserve at home.

Nor has the Government yet settled its shelter and evacuation policies, because it has not finished studying the effects of the radio-active contamination which might be caused by the "fall-out" from a hydrogen-bomb burst at ground level:

"Within a few miles of the point of burst it would be quite impracticable to provide protection against the violent explosive power of a hydrogen bomb. But beyond the area of devastation by blast and heat a considerable degree of protection against the effects of 'fall-out' during the period of intense radiation could be secured by shelter which need not be of very elaborate construction—for example, by a trench with overhead earth cover."

£70 Millions for C.D.

The Estimates for 1955-6 do not therefore include a large sum for shelters. The total provision for Civil Defence (excluding anything spent on the mobile defence corps) is just short of £70 millions. The total Estimates for the armed forces which the British taxpayer will have to find in 1955-6 will be £1,494,200,000—which is just about the

same as he will have had to find by the end of 1954-5. American aid will increase the total to be spent in the coming year by £43 millions.

The R.A.F. is to get the bulk of the money—£540 millions, compared with £537 millions in 1954-5. The R.A.F. is now the largest spender. Last year it was the Army, with £561 millions, but in the coming year the Army will take £484 millions. The Navy's share is to fall from £367 millions to £347 millions. The reason for this shift in the balance is the Government's decision to put increasing emphasis on the country's deterrent force, which "must rest primarily on the strategic air power of the West, armed with its nuclear weapons."

The primary task of the R.A.F. is to build up the V-bomber force, with its nuclear potential, to the highest possible state of efficiency and preparedness. The first squadrons of V-bombers will be introduced during this year. "The Navy also makes its contribution of heavy carriers to the Allied striking fleet whose great mobility and offensive power, to be augmented by guided missiles and by other modern equipment, will add powerfully to our ability to hit the enemy either independently or in support of Allied land forces and land-based air forces."

First Exchanges Critical

The Reserve Fleet is being reorganised so that those ships which are, or can be made, ready for almost immediate service in an emergency will either be maintained or refitted at the shortest possible notice. The White Paper emphasises that the first few exchanges in nuclear war would be critical, and that, therefore, the highest state of readiness in all three services is essential. The Government sums up its plans for the three services in these words: "We are planning for a better equipped and maintained active Fleet, and a reduced but much more highly prepared Reserve Fleet, a smaller, better disposed, more mobile army; and a more powerful air force, including in particular an effective strategic bomber force."

The speed of attack in nuclear war would inevitably have the result that many service units at home could not be directly employed in operations at the moment of attack. Such units would have to be used largely to aid the civilian population. The Government argues that the Civil Defence forces as at present organised in localities would have to meet the first call. But they would need to be supported by all the formed and disciplined bodies of the armed forces available in this island. Hence, all members of the armed forces, including the Home Guard, will in future receive training in elementary civil defence duties as part of their normal military training.

To link the local Civil Defence forces with the services a mobile defence corps, trained and equipped for fire-fighting, rescue, and ambulance duties, is to be formed. In an emergency the battalions of this corps, which will be distributed over the country, would be mobilised like any other unit of the reserve forces. Men for the corps will be selected from the Army and R.A.F., and will receive a month's whole-time training during their active service. Special training depots will be opened to train about 10,000 men a year. The first men will get their training towards the end of this year. When the men have finished their active service they will be posted to reserve battalions as near as possible to their homes. They will do their fifteen days' annual training with their battalions.

To Help Fire Service

The scheme, announced last year, to train R.A.F. reservists of Class H in civil defence duties is to be modified. They are now to be trained as firemen, so that in time of war the fire service (under central control) could expand rapidly. One training depot will be ready this summer with accommodation for about ten thousand reservists a year for their first period of basic training. A second depot will be needed for more advanced instruction.

The Post Office is planning to install a special network of communications, by cable and radio, to maintain long-distance contact in the event of attack. Plans have been drawn up to provide shipping facilities at the smaller ports and harbours in case the large docks are put out of action. Reserves of essential foods and materials are to be built up in the coming year.

WHI: 1234 - Ext.922

11th February 1955

TOP SECRET

Thank you for your letter of 10th February about experimenting with shelters and rescue rooms in the course of future atomic bomb tests.

It seems to me to be very sensible that work of this sort should be incorporated in the test schedules as it is the only means by which we can acquire satisfactory knowledge about a vital aspect of our defence arrangements. I shall see that a place is found for this in the draft report.

I shall also have a word with the authorities who have a direct responsibility for determining the range of experiments carried out during atomic tests.

Incidentally I noticed in the Press the other day that the Americans are proposing to try out some special types of shelter during their next trials. When we succeed in removing the difficulties which at present stand in the way of exchanges of atomic information between the United Kingdom and the U.S.A., I hope that we may be able to draw on their experience in matters of this sort.

(Sgd.) W. STRATH

(W. STRATH)

General Sir Sidney Kirkman, G.C.B., K.B.E., M.C.
Home Office

3/36558.

Home Office,
Horseferry House,
Dean Ryle Street, S.W.1.

PERSONAL

TOP SECRET

10th February, 1955

Dear Strath.

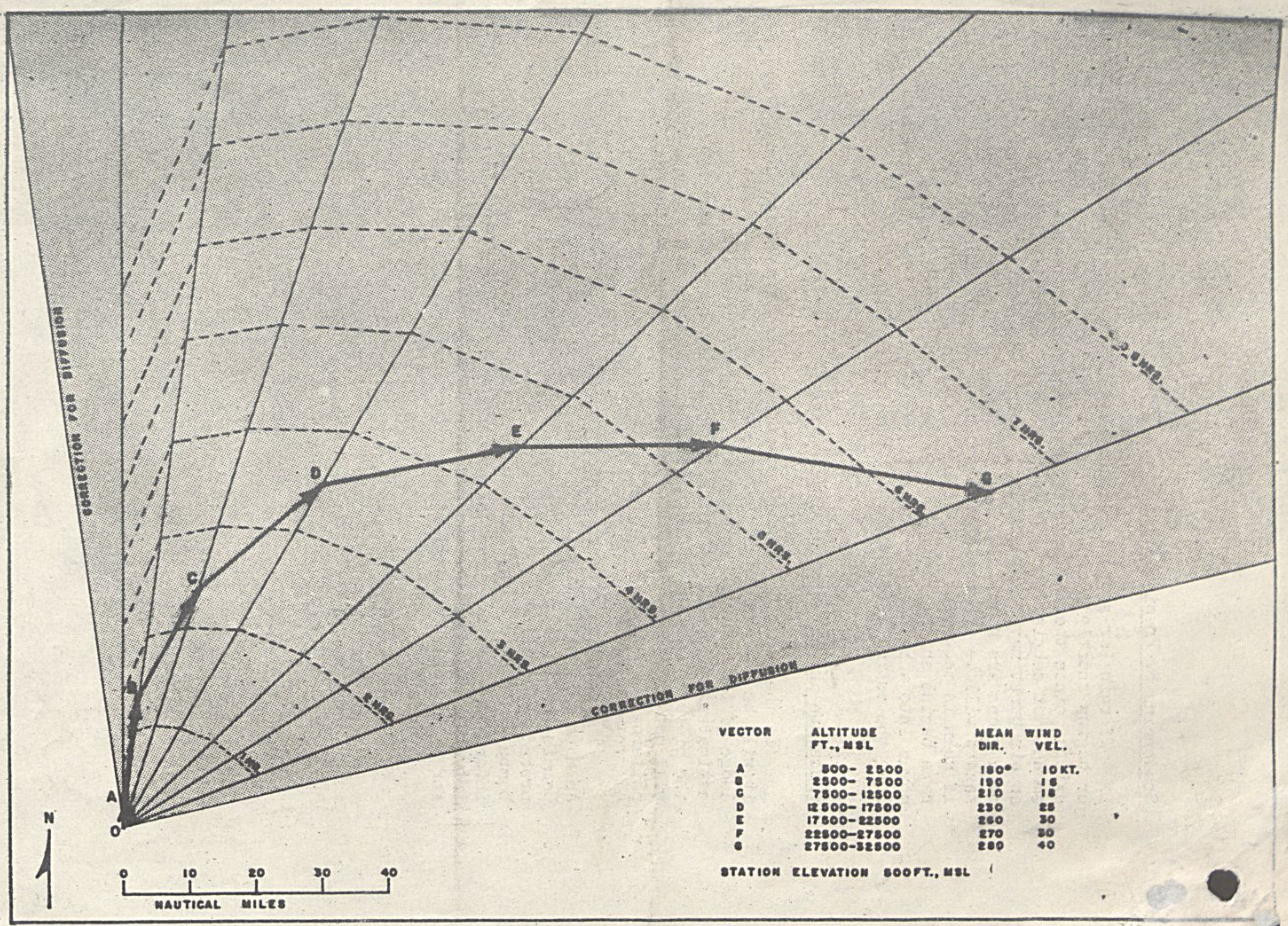
I had a meeting this morning on the exercise which I am holding at Sunningdale on the 23rd and 24th of this month. We were discussing the problem of shelters and I mentioned the point in the minutes of the last meeting of your Group, that the Home Office should experiment with different kinds of refuge rooms. Though much can be done from basic scientific knowledge and possibly also at places like Harwell, the real answer as to the effectiveness of various types of shelter or rescue room can but be an experiment when an atomic (not necessarily hydrogen) bomb is detonated. I was told that on such occasions in the past the emphasis has always been on experimenting on the design of weapon and that any civil defence information required has rather been pushed into the background. If this is so, it might be well that we should stress in our report that opportunity should be provided for civil defence to carry out such experiments as are generally practicable.

I will try and check up on this information before our next meeting. I imagine you would not require a paper from me on the subject.

Yours Sincerely.

S. C. Leitman

W. Strath Esq., C.B.



VECTOR	ALTITUDE FT., MSL	MEAN WIND DIR.	MEAN WIND VEL.
A	500- 2500	180°	10 KT.
B	2500- 7500	190	15
C	7500-12500	210	18
D	12500-17500	230	25
E	17500-22500	260	30
F	22500-27500	270	30
G	27500-32500	280	40

STATION ELEVATION 500 FT., MSL

FIGURE 1. EXAMPLE OF A FALLOUT DIAGRAM

FCDA-14954

Catalogue Reference:cab/21/4053 Image Reference:2

TOP SECRET

FUNCTIONS REQUIRED IF FALL-OUT OCCURS

1. Governmental, regional and area control.

2. Intimation of "H" bursts. Radio broadcast. Ground zero. Met. conditions. Probable areas of fall-out. Broadcast instructions. Battery receiving sets.

3. Reconnaissance of extent and pattern of fall-out. Helicopter and light aircraft teams. Mobile ground teams. Control. Collation and ~~de~~ diss cimation of information.

4. Human rescue organisation. Mobility. Communications. Radiation measurement.

5. Transport and control of injured and infected.

6. Reception and examination of infected.

7. Treatment and hospitalisation.

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E.R.

8. Evacuation from heavily contaminated areas. Care of homeless.

9. Fire-fighting organisation.

10. Demolition and salvage.

11. Decontamination organisation.

12. Emergency distribution of food and water.

13. Revival of essential services.

Water supply	Food distribution	Heating
Light	Communications	Imports

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14. Revival of damaged war making capability.

15. Law and order.

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Mr Strath/File

(20)

TOP SECRET
KLS/55/3

MR. STRATH'S GROUP

The Plan of Campaign

Facts about effects

Obviously we must fill any gaps here as quickly as possible so that our deductions can proceed from a sound foundation. We do not yet know how far the papers from Dr. Marley will complete the information called for by Conclusion (4) of the last meeting. I suggest that we run through outstanding points on ~~to Section~~ Conclusion 2 of the last minutes at the close of the next meeting. Subject to what Dr. Marley's papers contain it looks as if there may still be outstanding (i) a study of the implications of fall out for water supplies, (ii) an appreciation of the medical implications of fall out including the measures which should be taken to organise our research, etc., (iii) the meteorological appreciation.

Strategic Background

I have sent you separate notes about this commenting on the J.I.C. paper (S.G.(55) 1).

Agenda for the following meeting

I think the prime requirements are:-

(a) Stopping of any gaps still remaining in our factual information and in the strategic background.

(b) A study by the Home Office of the implications of fall out and the strategic guidance for:-

(i) Fire-fighting and rescue work by all echelons of the Civil Defence Services.

(ii) Evacuation policy.

(iii) Shelter policy.

I think General Kirkman is preoccupied more with operational plans than ~~our~~ wider policy guidance in these fields. We need a document drawing out the broad policy deductions for these three subjects which would be suitable as recommendations to Ministers and thereafter as the basis for planning guidance to Departments.

(c) A study by Sir Robert Hall of the effects on the United Kingdom economy of a hypothetical attack on the scale outlined by J.I.C. in S.G.(55) 1 supplemented by any further information gleaned as to the significance of the supplementary effects of other weapons besides H Bombs.

If we are to report by the end of January this study will probably have to be more general and considerably shorter than the study previously done on the basis of a 200 A Bomb attack. It may also have to consider the alternative effects of an attack with or without extensive fall out effects.

(d) A study of the problems of organisation and control to be faced in the light of the study of (c) and bearing in mind the assumed objective of the enemy as defined in paragraph 8 of S.G.(55) 1 - especially paragraph 8(b).

4th January, 1954

E.R.

TOP SECRET

MR. STOCK

(19)

(Copies to: Brigadier Godwin
W.P.S. Principals)

Notes on S.G.(54) 5

You asked me for a few comments on the above paper. These are set out below and include points raised by my colleagues.

(1) This paper is based on United Kingdom information only. Is this because no other sources of information are available, i.e. United States of America, or because we consider our own information more reliable?

(2) Any action taken after an explosion, to be effective, must depend on accurate information being available at some central point on the ever changing contours of contamination.

(3) If the population is to take the best possible action it would seem that it is essential that:-

(a) That they have a clear and complete understanding of the problem before the outbreak of war.

(b) That they have a means of receiving instructions.

(c) That they understand and have taken all precautionary measures that are possible.

The question of the amount of information given out requires an assessment of:-

(a) The moral obligation of a Government to spell out the whole story.

(b) Necessity of wide-spread knowledge if plans are to be effective.

(c) The likely effects of this knowledge in determining people's actions should war break out. This again depends on the confidence which the Government has engendered due to the measures it has carried out.

(4) It would be desirable if we got our ideas straight on exactly what are to be the tasks of mobile columns, not only in relation to conventional rescue work, but in relation to the fall-out problem. We must have a clear idea of the basic purpose of the whole operation (presumably saving life) before we embark on developing operational techniques, e.g. helicopters and radar sets, and all our plans should be set in the context of the overall conditions prevailing rather than in individual facets of the total problem.

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E.R.

(5) It is of interest to note that after the allied air attacks on Hamburg in July/August 1943, the Germans operated mobile columns of Service personnel, some 15,000 all told, on unskilled Civil Defence work (see United States Strategic Bombing Survey 1945). In Hamburg the area of damage was approximately 30 square miles, This corresponds to a circular area of damage with a circumference of 19 miles. At the present we envisage that round a hydrogen bomb explosion there will be a 45 mile sector of the circumference ~~round this explosion~~ where mobile columns could operate. On the same basis as X German experience at Hamburg, this would imply the use of some 30,000-45,000 troops.

G.W. Robertson

5th January, 1955

I don't think X is a true analogy because the degree of devastation within the "circle" differs absolutely, not merely relatively; and life would be extinct at an epicentre, whereas Hamburg had no comparable epicentre.

Kned. 4/1.

Mr Strath.

(513) Dd.D922/W134369 20,000 1/54 JC&S Gp669

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TOP SECRET

J.P.G/55/1

MR. STOCK

J.I.C.(55) 12

Terms of Reference

The form and scale of attack to which the United Kingdom would be exposed in the event of general war.

Likelihood

General war most unlikely in the foreseeable future.

Even unintentional war is unlikely.

Planned attack on the United Kingdom is not expected before about 1960.

Enemy's Aims within United Kingdom

To knock out airfields from which nuclear attacks could be launched against the Soviet Union.

To destroy the organisation of Government and control.

To render the United Kingdom useless as a base for any form of military operations.

They will not hesitate to destroy great parts of the United Kingdom, and their aims will remain constant.

Threat

H-bombs by aircraft not possible before 1958.

H-bombs by submarine possible before 1958.

H-bombs by ballistic rocket long term and unpredictable.

Objective	Means
Airfields	A-bomb from aircraft at optimum height.
Seat of Government	"
London	The H-bomb from 20,000 feet.
The country as a base	10 x 10 megaton H-bombs from ground level in west coast locations.

Warning

High level air delivery 20 minutes to 1 hour.

Low level air delivery 3 minutes minimum.

Submarine delivery none now. Some later.

Questions left unanswered

Have they the capability NOW of delivering sufficient A-bombs by air:-

(a) to knock out airfields from which nuclear attacks could be launched, and the seat of Government;

(b) to knock out London by a concentration of A-bombs.

Have they the capability NOW of placing and firing 10 H-bombs at ground level in west coast locations by ship or by submarine. If so will there by any warning?

4th January, 1955

The Times
3 Jan 55.

PLANNING FOR DEFENCE

IMPLICATIONS OF THE HYDROGEN BOMB

TO THE EDITOR OF THE TIMES

Sir,—The further one thinks into the problem created by the hydrogen bomb, and its implications, the more questionable it becomes whether present defence planning is realistic. At the same time the effort brings a deepening sympathy for the planners because of the immense difficulty of bridging the gulf between customary ideas of warfare and the super-revolutionary effects of atomic power.

It is very hard to relate warfare as known in the past to warfare where atomic bombs, missiles, and shells can be employed in hundreds or thousands, and where thermo-nuclear (hydrogen) bombs each measured in millions of tons of high explosive are also available in quantity. (The original Hiroshima bomb was equivalent to a mere 20,000 tons of T.N.T.) Once such weapons are used it is scarcely conceivable that the war could continue, even in a "broken-backed" form. The conduct of war is "organized action," and this collapses where chaos reigns.

In the case of this country, where the vital targets are closely grouped, it has been estimated that as few as five thermo-nuclear bombs might suffice, and that 10 would almost certainly suffice to blot out all its main centres of industry—comprising half the population. Still fewer would suffice to paralyse the vital centres of France, Belgium, and Holland. Moreover, paralysis, and collapse, can be produced by moral effect even where destruction does not take place.

To prevent such a catastrophe, air defence would have to attain nearly 100 per cent. effectiveness of interception at the outset, and that is almost inconceivable. The most optimistic estimate from any authoritative quarter is that "one out of every four Soviet bombers" might be intercepted. In any case there is no means in existence or in prospect of intercepting atomic missiles. By 1945 the Germans had successfully test-fired a V2-type rocket with a range of about 400 miles, and had worked out plans to extend it—just before their research station at Peenemunde was captured by the Russians. The range of the V1 type, then only 150 miles, has already been trebled and its accuracy improved. London is 450 miles from the Russian positions in Germany, Paris less than 400 miles, while Brussels, Antwerp, and Amsterdam are barely 250 miles distant.

Hence, the only real defence is the deterrent power of retort. This is, however, a very potent safeguard against an attack of similar kind—or any that presents a vital threat. It would be the blindest of gambles for either side to base a war plan on destroying the other's power to retaliate. The Communist rulers have never inclined to dangerously blind gambles; indeed, they have shown themselves cautious in calculation to an ice-cold point. The idea of a sudden "knock-out" makes no sense where there are many airfields from which the "hydrogen bombers" might take off—it would be like staking one's life on picking out the proverbial "needle in a haystack." That conclusion applies both ways.

Unfortunately a grave risk remains that an atomic war might develop unintentionally. The authorities agree in saying it would be "mutual suicide," yet present defence planning runs contrary to that conclusion. The preparation and training of the western forces are now to be based on the use of "tactical" atomic weapons, with the idea of counter-balancing the potential attacker's greater number of men. The idea has attractions on the surface, but on closer examination the advantages fade.

It is hard to draw, and even harder to maintain, a dividing line between "tactical" and "strategical" action with such weapons, so it is extremely doubtful if they could be used without precipitating all-out war, with hydrogen bombs. In such a war there would be little value in the armies (with tactical air forces) which the North Atlantic Treaty Organization is building up for the defence of western Europe. These could not maintain a defence once their homeland sources of supply were wrecked—and if their homelands were annihilated their purpose would have vanished.

A massive attack by "conventional" forces only has become very unlikely. For it will be obvious to a calculating aggressor that the less we are able to check it with similar forces the more likely we should be driven to retort with hydrogen bombs. The value of armies lies in providing a non-suicidal defence against attack. To arm them with atomic weapons is to destroy the case for maintaining them. In that form they would increase the risks of spreading a local conflict into a universal conflagration without diminishing the fatal prospect.

The soldiers responsible for defence planning naturally desire the maximum possible insurance, and it is not their responsibility to judge whether the apparent addition offered by nuclear weapons is outweighed by the increased risk of homeland chaos and collapse. In accepting the argument for such added insurance the statesmen may hopefully imagine that they can restrain its use until the need is clear. This is a frail hope.

The supreme fact of the hydrogen bomb era is that war has become palpably suicidal. Here is the real deterrent to the kind of attack that Supreme Headquarters, Allied Powers, Europe, is planning to meet, and it embraces all contingencies except guerrilla-type action combined with political subversion, or local advances in remote non-vital areas. To concentrate on preparing for the improbable is a waste of our economic resources—dancing to the Communists' tune in the self-exhausting way they wish us to do.

For the lesser, more likely, contingencies we need an extensive gendarmerie backed by "fire-brigade" forces of high efficiency and mobility, in constant readiness. Short-service conscripts are not suited to such tasks. By reorientating our defence preparations on the basis of the probable, great savings could be achieved.

The maintenance of the hydrogen bomb deterrent to a "Great War" has to be the primary charge on the defence budget. It calls for a strategic air force of superlative technical quality and performance, but not of 1939-45 War quantity—especially as its essential purpose is to prevent war, rather than to pursue the now obsolete and nonsensical concept of "winning a war." There is scope for big savings in ordinary bombing forces, and in navies. Moreover, as no air defence is capable of preventing a catastrophic penetration by "hydrogen bombers," or bombardment by atomic missiles, it is hard to see any adequate reason for large expenditure on air defence.

A realistic appreciation of the military factors could change the whole economic outlook for the better, while also providing greater security, by "putting first things first."

Yours, &c.,
B. H. LIDDELL HART.
Wolverton Park, Buckinghamshire.

1 Brig. Godwin
2 Mr. Befeck
3 W/Cdr Carter
4 Cdr. Eardley-Wilmot
5 Mr. Robertson
6 Mr. Martin - to file

TOP SECRET

KLS/54/73

Note of a Discussion in
Mr. Strath's Room, on
Tuesday, 21st December, 3.30p.m.

PRESENT:

Mr. Strath
Dr. Marley
Mr. Stock

Mr. Strath outlined the plans which would shortly be submitted to Ministers for training personnel of the Army and Air Force in Civil Defence and for building up a number of regional mobile columns manned with R.A.F. and Army personnel, and specially trained for rescue and fire-fighting duties in support of civilian Civil Defence Services. Before the latter project was submitted for the approval of Ministers, it was important to establish that the functions envisaged for the new military mobile columns were fully compatible with the conditions which would exist in the event of a ground burst thermo-nuclear explosion, in so far as it could be gauged from the scientific knowledge now available to us about Fall-out.

Discussion brought out the following points:-

(a) It would not be safe to assume that the enemy would necessarily employ his thermo-nuclear weapons with the object of maximising the Fall-out effect. He might opt to achieve the maximum damage by blast and heat by air burst explosions, which would not create serious problems from Fall-out. The radius of damage by heat and damage from air burst would be greater than from a ground burst, but the mobile columns would be able to deploy their resources for rescue and fire-fighting round the perimeter of the damaged area from the outset, and their operations would not be handicapped by radio-activity.

(b) Assuming, however, that ground burst nuclear explosions would occur, the inner zone of damage by heat and blast would have a perimeter of the order of sixty miles in length. Except on the hypothesis of calm air at all levels, which was most unlikely, about three-quarters of the perimeter - i.e. a front of forty-five miles or so - would be approachable by the mobile columns in conditions similar to those under (a). In this zone radio-activity would not be the factor limiting ~~other~~ their operations.

(c) The plume of Fall-out stretching downwind from a fifteen mile segment of the sixty-mile perimeter would deposit radio-active material in elongated contours which for the most part would run parallel in the downwind direction. Thus, the intensity of radio-active contamination would vary relatively little at any given distance from the edge of the plume towards the median line of the plume; though the conditions facing the Civil Defence columns would be complicated by damage from heat and blast in these sectors nearer the epicentre of the explosion.

(d) Assuming that the Fall-out plume would have an average width of about fifteen miles over a considerable distance from the point of explosion, it was calculated that it should be possible for personnel of the mobile

columns to operate for four or five hours at a stretch at the edge of the plume and near its neck during the second day after the explosion. Each individual after his four or five hours stretch would have to retire for several days to recuperate in an area unaffected by Fall-out. The corresponding time limit on the second day for personnel operating within three to five miles of the centre of the fifteen-mile wide plume would be about two hours. At the centre of the plume the time limit on the second day would be half an hour; exposure here for two hours would be lethal.

(e) It seems likely that mobile columns would find considerable difficulty in tackling their task from the flanks of the plume in close proximity to the perimeter of blast and heat damage, since fires would be raging in this sector and would tend to spread downwind along the line of the plume.

(f) A high degree of skill would be required of the personnel in mobile columns tackling the area of the plume. Their efficiency would be governed very largely by the extent to which they were able to take advantage of the considerable variations in radio-activity which would exist in consequence of the screening effects of buildings, etc. Operations would have to be conducted from under cover and much would depend on effective communications. Detailed knowledge of conditions in the plume area would be an essential prerequisite to the deployment of mobile columns on rescue and fire-fighting work; but it should be possible to obtain a rapid and effective assessment of the situation in the Fall-out area by inspection from the air, e.g. by helicopter. It might be that first-hand information of conditions in the zone of the plume could be conveyed to the Command posts in shelter on the ground from a television camera in a helicopter.

(g) The conditions of devastation in proximity to the neck of the plume would be such that the casualty rate was likely to be influenced considerably by psychological factors. Rescue operations might well have to take one of two forms - either deployment in limited and carefully selected areas soon after the explosion, or slower deployment on a more methodical basis.

(h) The screening effect of buildings, etc. and the probability that wind variations would tend to spread the area of Fall-out together mean that the theoretical safety limit of working time within the plume area could be expected to be less restrictive than was implied by the calculations recently submitted to Ministers.

24th December, 1954

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THE STAR

11th November, 1954

'CAN LAY WASTE A CONTINENT'

MR HAROLD TALBOTT, U.S. Secretary for the Air Force, said today that new weapons exist which "can lay waste an entire continent—men, women, children, even beasts and vegetation."

In a speech at an ex-Servicemen's ceremony at the tomb of the U.S. unknown soldier in the Arlington National Cemetery, he declared:

"They can abolish in a single night not only an army, not only a nation, but a whole civilisation."

Mr Talbot said that in his official position he has "intimate knowledge of these weapons," adding:

"Some of them are of such awful power that even the men who build them cannot fully visualise the carnage that would follow their use."

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HOUSE OF COMMONS

APRIL 5, 1954

(*Extract from the official report, volume 528, number 89*)

"That this House recognising that the hydrogen bomb with its immense range and power as disclosed by recent experiments constitutes a grave threat to civilisation and that any recourse to war may lead to its use, would welcome an immediate initiative by Her Majesty's Government to bring about a meeting between the Prime Minister and the heads of the Administrations of the United States of America and the Union of Soviet Socialist Republics for the purpose of considering anew the problem of the reduction and control of armaments and of devising positive policies and means for removing from all the peoples of the world the fear which now oppresses them and for the strengthening of collective peace through the United Nations Organisation."

The PRIME MINISTER:

* * * * *

"We do not dissent in principle from the Motion which the Opposition have placed upon the Paper and I congratulate the right hon. Gentleman on having procured agreement to it. We shall not divide against this Motion provided it is clearly understood that the word 'immediate' does not commit us to action at an unsuitable time or lead only to courting a polite deadlock or even provoking a refusal."

* * * * *

MR. MORRISON:

* * * * *

"The Prime Minister has manifested some doubt about the word 'immediate'. It is possible to exaggerate the word and to say that it might mean 'the next five minutes'. But I say this to the Prime Minister, because although I am very glad he has said that the Conservative Party does not propose to divide on the Motion—and I am glad that that should be so—I hope there is no misunderstanding of the word 'immediate'.

When we say 'immediate' we mean that the Government should take immediate steps to set diplomatic action in motion, in the best and most effective way, between the three Powers concerned, with a view to the heads of Governments meeting for the purpose of discussing this whole problem and in due course the

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related problems of disarmament in general. Therefore, when the House passes, as I hope it will, unanimously tonight, this Motion, it is our hope that there may be an immediate initiative on the part of the Government. That is what we mean in the Motion which we submit to the House."

* * * * *

MR. EDEN:

* * * * *

"Then I would say that, thirdly, there is any and every opportunity that presents itself either at the United Nations or in any other way, for talks between Ministers at any level, and, finally, the meeting at the highest level of all. All or any of those means we are prepared to employ, and ready to employ, and it is in that sense that we accept this Motion. We shall employ all and every one of them, but, as a Government, we think that we are entitled to say how, when and where to put the emphasis at any given time.

There is one other warning which I must give to the House—and it is important. One cannot divorce these technical problems entirely from the general international scene. We shall not be able to make progress, even at the highest level, unless some progress is taking place in the general international picture. It may be that Berlin did, to some extent—I think it did—make it easier for later discussions to take place. It was not that we reached agreement but, as a result of the atmosphere at Berlin, there was, perhaps a greater willingness to discuss than before.

It may be that Geneva can help that still further. I hope so. That will be the aim and object with which we shall go to the task. If so, those events, or some other combination of events, may facilitate a meeting at any time at the highest level. The moment we think there is the least chance of such a meeting being fruitful we shall not hesitate to go for it. Why should we not? After all, my right hon. Friend suggested it. I am not criticising the right hon. Gentleman the Leader of the Opposition, but during the six years when his party were in power there were no meetings at the highest level."

* * * * *

The Resolution was carried without a division.

HOME OFFICE

SCIENTIFIC ADVISERS' BRANCH

The Circulation of this paper has been strictly limited.

It is issued for the personal use of ..... Mr Shath

CD/SA 54

SECRET

Copy No. 54

Some Aspects of Shelter and Evacuation Policy to meet H-Bomb threat

1 Introduction

At the present time, with such air raid shelters as are at present in existence and allowing for the planned evacuation of the priority classes, the deaths from a single hydrogen bomb (assumed to have a power a thousand times that of the Nagasaki atomic bomb) on London would be nearly $2\frac{1}{2}$ million, and from five bombs, one each on London, Birmingham, Liverpool, Manchester and Glasgow over 6 million. The first object of Civil Defence must be to prepare a scheme to reduce this figure. No attempt is made in this note to plan such a scheme, but the effect on casualties of certain arbitrary shelter and evacuation measures is discussed in order to indicate the order of magnitude of the reduction which a properly worked out scheme might be expected to achieve.

2 Method of Estimating Deaths

The deaths from a nominal atomic bomb among a population of standard density (43.56 per acre) all in houses have been estimated (CDJPS(EA)(48)14 (Revised)) as 31,000. This is equivalent to everyone within 0.6 miles of the bomb being killed and no one being killed outside this radius. If the generally accepted sealing laws for blast heat and gamma radiation are assumed to apply to hydrogen bombs, then it will be sufficiently accurate for present purposes if we assume that for them everyone is killed within a radius of $0.6\sqrt[3]{F}$ and no one is killed outside this radius. (Where F is the lower factor of the bomb expressed as a multiple of the lower of the nominal bomb). This assumption ignores the possibility that under certain circumstances there could be a large number of additional casualties due to fall out or radio-active crater debris.

From this and from the known night-time population distribution of our major cities (CD/SA 33), it is a simple matter to calculate the deaths from a bomb of any power on the centre of any particular city.

It must, however, be emphasised that the figures given in this note are deaths only. For the nominal atomic bomb it has usually been assumed that the injured are about equal in number to the killed. For the five hydrogen bombs considered in this note it is fairly certain that the killed would outnumber the injured due to the high population densities in the central (killed) areas as compared with the outer (injured) annuli. However, for the present, no attempt has been made to estimate the number of injured, but in considering the figures given in this note the existence of additional very large numbers of injured must be borne in mind.

3 Deaths with no shelter or evacuation

Table 1 shows the deaths that would result from a bomb with a power of 100N, 500N and 1000N on the centre of each of our five largest cities with no shelter or evacuation.

Table 1

Deaths with no evacuation and no shelter

City	Power of bombs		
	100N	500N	1000N
London	830,000	2,420,000	3,340,000
Birmingham	500,000	1,070,000	1,360,000
Glasgow	780,000	1,180,000	1,330,000
Liverpool	590,000	1,080,000	1,280,000
Manchester	560,000	1,070,000	1,350,000
Total	3,260,000	6,820,000	8,660,000

It will be seen that deaths from the five 1000N bombs total over 8.6 million.

4 Effect of Shelter on deaths

Detailed designs of shelters required to give protection at specified distances from hydrogen bombs of various size, particularly if burst at ground level, have not been worked out. However it is of some interest to see what reduction in deaths would result from shelters of specified performance, even though it is uncertain just what strength and thickness would be required to give that performance. The simplest way of specifying shelter performance is by means of the "Safety Rating" concept developed in CD/SA 48. The safety rating of a shelter was there defined as the saving in life, expressed as a percentage of the deaths without shelter, resulting from the use of the shelter in an area of uniform population density. This shelter with a safety rating of 80 would save 80% of the lives that would have been lost if everyone had been in a house. Put in another way, shelter with a safety rating of 80 would reduce the area within which deaths occurred to one fifth of that for people in houses, and therefore the radius of death to $\frac{1}{\sqrt{5}}$. For a bomb with a power factor of F the equivalent radius of death if everyone is in a shelter with a safety rating of 80 will therefore be $\frac{0.6\sqrt[3]{F}}{\sqrt{5}}$. Similarly for shelter with a safety rating of 90 the radius will be $\frac{0.6\sqrt[3]{F}}{\sqrt{10}}$.

Although, as stated above, the design details of shelters to give these safety ratings have not been determined, it seems probable that surface or trench shelters of rather less than Grade A strength (say 1000 lb/sq.ft.) would be required to give a safety rating of 80, and that a strength of about 2000 lb/sq.ft. would be required for a safety rating of 90. For small street surface shelters the extra cost of an increase in strength of this sort is very small (e.g. the structural cost of a 12"/1000 lb/sq.ft. design is given in CD/SA 48 as £15.2 per person, based on seated capacity) and of a 12"/1400 lb/sq.ft. design as £15.5 per person) and detailed studies may well show that shelters with a higher safety rating than 90 are a practical proposition.

From the formulae for equivalent radii of death given above, and from the population distribution given in CD/SA 33 we can calculate the expected deaths in these two types of shelter under the same conditions of attack as were given in Table 1 for a population all in houses. The results are given in Tables 2 and 3.

Table 2

Deaths with no evacuation but with everyone in a shelter with a Safety Rating of 80

City	Power of bomb		
	100N	500N	1000N
London	135,000	474,000	785,000
Birmingham	129,000	353,000	484,000
Glasgow	223,000	576,000	760,000
Liverpool	159,000	401,000	565,000
Manchester	117,000	386,000	540,000
Total	763,000	2,190,000	3,134,000

Table 3

Deaths with no evacuation but with everyone in a shelter with a Safety Rating of 90

City	Power of bomb		
	100N	500N	1000N
London	59,000	216,000	367,000
Birmingham	64,000	191,000	296,000
Glasgow	115,000	327,000	489,000
Liverpool	78,000	238,000	340,000
Manchester	49,000	186,000	315,000
Total	365,000	1,158,000	1,807,000

It will be seen by comparing Tables 2 and 3 with Table 1 that the reduction in deaths achieved by these shelters decreases with increasing bomb size; thus shelter with a safety rating of 80 reduces deaths by 77% against the 100N bomb, but only by 64% against the 1000N bomb. Similarly the 90% shelter reduces deaths by 89% against the 100N bomb but only by 79% against the 1000N bomb. The reason why these shelters fall increasingly short of their nominal safety rating against bigger and bigger bombs is, because of the lower population density in the outer annuli. For the same reason as the bomb size increases, so does the proportion of the shelter provided which is wasted since the occupants are killed whether they are in shelter or not. This raises the question as to whether, against very large bombs, it is worth while providing shelter in the area immediately round the probable aiming point. The value of any shelter is clearly directly proportional to its chance of saving the occupants from death or injury; if no bomb falls near a particular shelter it is wasted on that occasion because the occupants would have been safe without shelter, and if the bomb falls so close that the occupants are killed anyway, it is for good and all wasted. Thus there exists round any

bomb, for any particular type of shelter, an annulus where people in houses would have been killed or injured, but where shelter would have protected them. In practice, of course, this annulus will not have sharply defined boundaries. Some people closer to the bomb would be saved by shelter and some outside the annulus would have become casualties without shelter, but are saved by it. For the purpose of this preliminary study however, we shall not be too far out if we regard this annulus as having sharply defined boundaries and we shall assume that everyone within it is saved by the shelter.

If we knew exactly what size the bomb was going to be and where it was going to fall shelter policy would therefore be a very simple matter; we should evacuate the people from a circular area round the bomb where it was impossible to provide shelters sufficiently strong to protect them, and we should provide shelters in, and only in, the annulus where people would be killed or injured in houses but where shelters would protect them. Shelters in this annulus would have a "value" of 100%, i.e. they would be certain to save their occupants from death or injury. With the nominal atomic bomb the uncertainty of what aiming point or points the enemy will choose and the expected vagaries of bomb fall about this aiming point, make it not very useful to try to fit our shelter provision to the probable location of this annulus. This is illustrated in Fig.1 which shows the percentage of the shelter provided which actually saves life for shelter with a safety rating of 80 at different distances from the aiming point for four different values of the probable aiming error (P). It will be seen that over the most likely range of P (0.25 miles - 1 mile), this percentage never exceeds 50%. Corresponding curves for the 100N and 1000N bombs are given in Figs. 2 and 3, and the much higher value of shelter (in the right place) for similar aiming errors should be noted.

The considerations discussed above strongly suggest that the right policy against the hydrogen bomb would be to evacuate the central areas of our larger cities and to provide shelter where it is most useful, i.e. in the annulus surrounding the central evacuation area. The optimum size of this central evacuation area clearly depends on the size of bomb likely to be used, and on the standard of protection provided in the shelter annulus; Figs. 2 and 3 suggest that it should have a radius of about $1\frac{1}{2}$ miles for the 100N bomb and about 3 miles for the 1000N bomb if shelter with a safety rating of 80 is provided in the surrounding annulus. As a result of further studies, and of further information about the hydrogen bomb, it may be possible to determine the largest size of bomb likely to be used. If this maximum size of bomb can be determined it will be comparatively simple to determine the optimum size of the central evacuation area for various standards of protection in the surrounding shelter annulus; from this study and from an estimate of the relative "cost" of shelter and evacuation it should be possible to determine the best overall policy.

In the meantime, however, it is of some interest to examine the effect on casualties of an arbitrary evacuation area of radius 5 miles in the case of London and 3 miles in the case of Birmingham, Glasgow, Liverpool and Manchester, in conjunction with shelter having a safety rating of 80 and 90 in the surrounding annulus. In each case the evacuees from the central area are assumed to be accommodated in the surrounding annulus, arbitrarily taken as between 5 and 15 miles in the case of London and between 3 and 7 miles in the case of the other four cities. The factors by which this evacuation would increase the population density in the 'reception' annulus are as follows; London 1.5, Birmingham 1.6, Glasgow 2.5, Liverpool 1.9 and Manchester 1.7. The deaths resulting from an attack with 1000N bombs after this scheme had been implemented are shewn in Tables 4 and 5.

Table 4

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter having a safety rating of 80.

City	Position of bomb		
	Central	2 miles from centre	In position to cause maximum deaths
London	0	0	518,000
Birmingham	0	159,000	256,000
Glasgow	0	171,000	247,000
Liverpool	0	174,000	247,000
Manchester	0	164,000	257,000
Total	0	668,000	1,525,000

Table 5

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter with a safety rating of 90.

City	Position of bomb		
	Central	2 miles from centre	In position to cause maximum deaths
London	0	0	261,000
Birmingham	0	56,000	155,000
Glasgow	0	64,000	152,000
Liverpool	0	67,000	152,000
Manchester	0	62,000	151,000
Total	0	249,000	871,000

It will be seen from Tables 4 and 5 that, with this scheme of total evacuation of a central area and shelter in the surrounding annulus, a central bomb causes no deaths at all. Clearly, however, the enemy would be aware of our provisions and might well choose to drop his bombs where they would cause maximum casualties. On average, and without allowing for local concentrations which would be bound to occur in the "reception annulus", this would be at about 7 miles from the centre in the case of London and about 4 miles for the other cities. The average deaths from bombs in these worst positions are therefore given in Tables 4 and 5. Comparing these figures with those to Table 1 it will be seen that evacuation plus shelter with a safety rating of 80 has reduced deaths by 82%, and plus shelter with a safety rating of 90 by 90%.

Conclusion

Without shelter or evacuation, the deaths from an attack with only five hydrogen bombs might total over $8\frac{1}{2}$ million. The primary object of Civil Defence must be to reduce this figure. Neither evacuation alone nor shelter alone could reduce these deaths to a manageable proportion, but with a suitable combination of the two, consisting of the total evacuation of the population of the central areas into the surrounding annuli where shelter would be provided, it should be possible to reduce the maximum deaths from this particular attack to something of the order of one million.

April, 1954.

E.L.W.

OSA.41/4/32.

1990/54

CD/SA 54.

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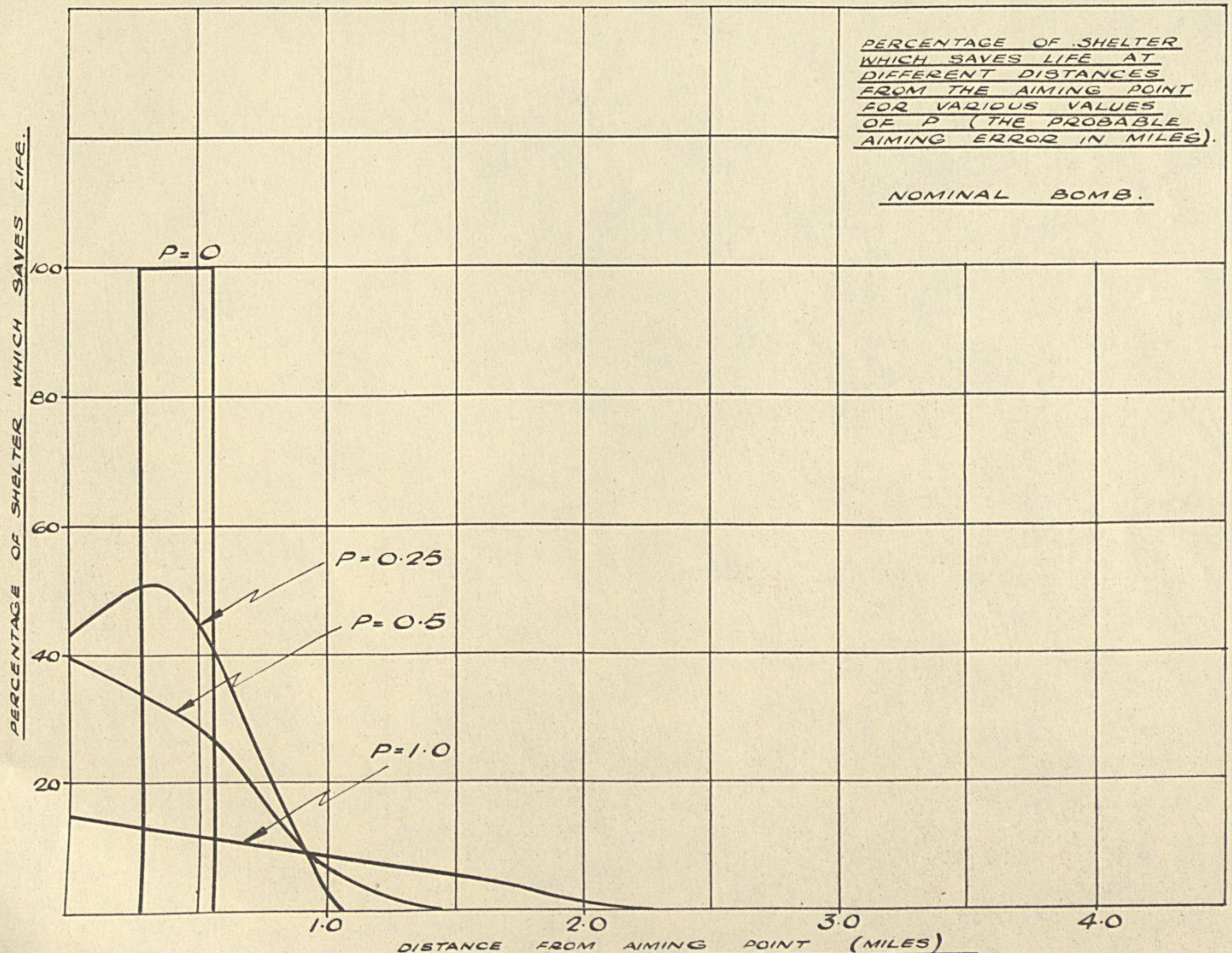

FIG. 1.

CO/SA 54.

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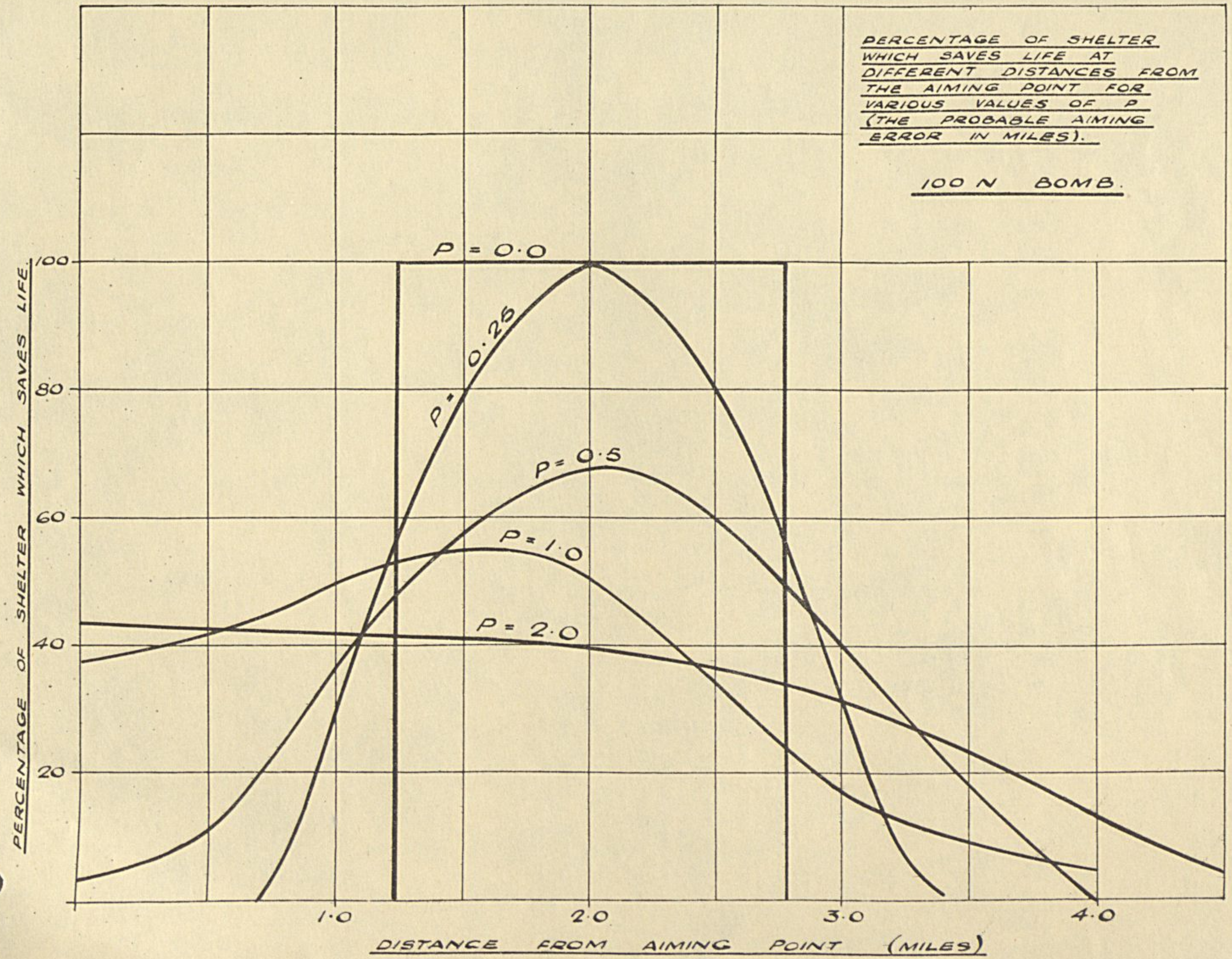

FIG. 2.

CD/SA 54.

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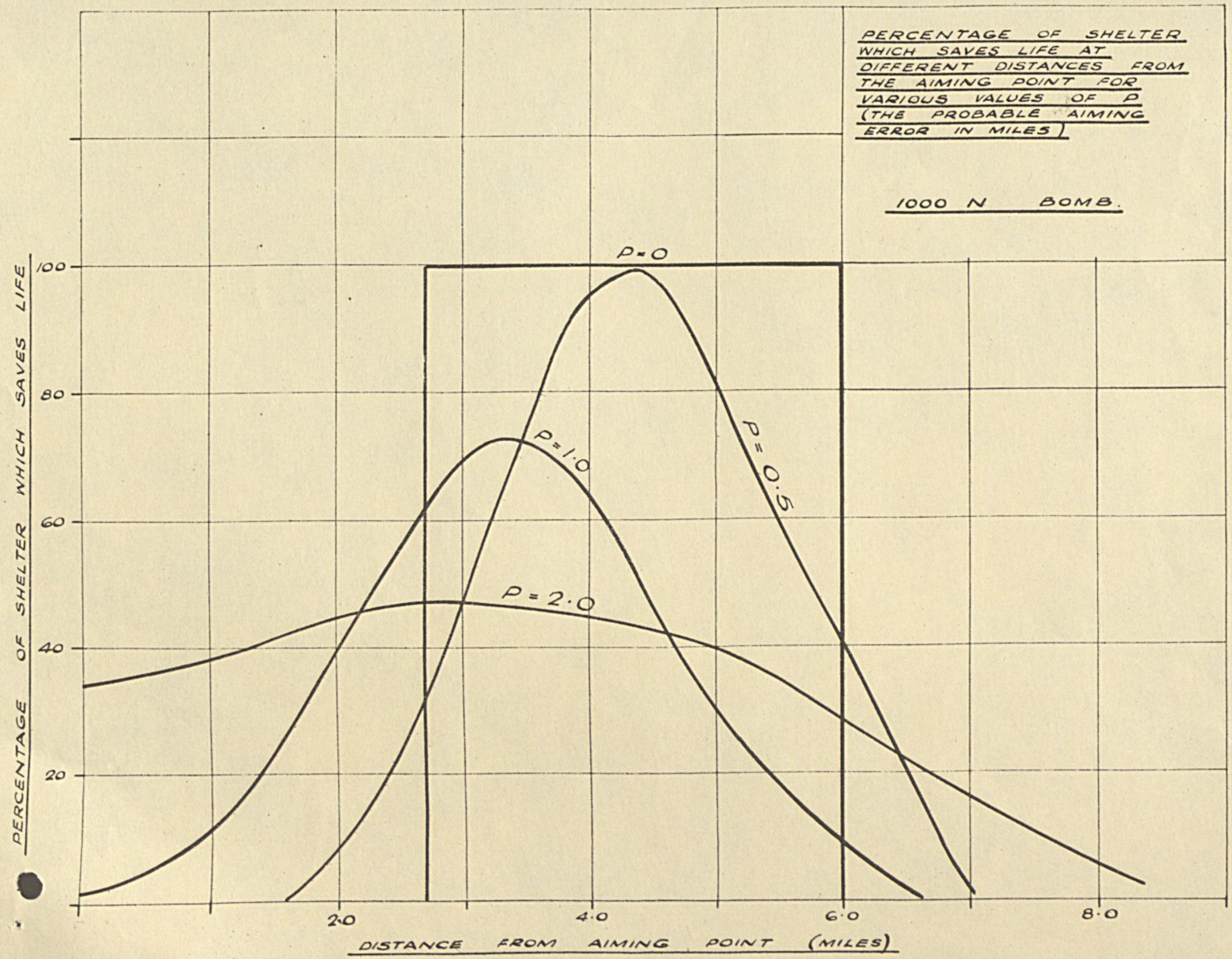

FIG. 3.

THE MANCHESTER GUARDIAN

18th February, 1954

DEVASTATION OF HYDROGEN WEAPON

Island Obliterated in U.S. Test

Chicago, February 17

The chairman of the Joint Congressional Atomic Energy Committee, Mr. Sterling Cole, hinted to-day that the United States might have hydrogen weapons even more potent than the experimental one which tore a crater a mile wide and 175 feet deep in the floor of the Pacific Ocean in 1952.

He said that the United States had "in being" an entire family of atomic weapons, some of them 25 times more powerful than the bomb that destroyed Hiroshima in 1945.

Mr. Cole gave details of the 1952 experiment in a speech at a commercial lunch here. He said:

"The thermo-nuclear test of 1952 completely obliterated the test island in the Eniwetok Atoll. It tore a cavity in the floor of the ocean - a crater measuring a full mile in diameter and 175 feet in depth at its lowest point. Within this crater, one could place 140 structures the size of our nation's Capitol.

If it occurred in a modern city, I am told that the heat and blast generated in the 1952 hydrogen test would cause absolute destruction over an area extending three miles in all directions from the point where the hydrogen device exploded.

This is an area of complete devastation - using the word 'complete' in its most precise meaning - six miles in diameter. The area of severe-to-moderate damage would stretch in all directions to seven miles from ground zero.

Finally, the area of light damage would reach to ten miles from the point of detonation. In other words, an area covering 300 square miles would be blanketed by this hydrogen explosion."

Because of what he called "the appalling meaning of the hydrogen bomb." Mr. Cole said that "it is not enough to notify an enemy that the attempted destruction of our own cities would be automatically answered by the destruction of his."

"Atom-Rattling"

Mr. Cole said that security prevented him from commenting on where "our hydrogen weapons programme now stands and from outlining the directions in which it is now moving, but I can assure you that it is moving." He felt that "it is more sinful to conceal the power of the atom than to reveal it." He referred indirectly to a

recent remark by the Secretary of Defence, Mr. Charles Wilson, who told a news conference that he wished that there was less "atom-rattling."

Russia's capacity to deliver a crippling atomic or hydrogen weapon attack on the United States at present might be debatable, but "beyond any question" the Russians would be able to do so in "one or two or three years from now." He was confident that the United States could strike back, but that would only be a half-measure. "We must make it clear that our continental defence system could cripple and repel any air fleet directed against us."

At present it was possible that nine of ten enemy planes could reach their targets - "and this is an age when only one hydrogen weapon would be needed to destroy the vitals of any American city." Mr. Cole called for increased defences, including the use of "small-size atomic weapons specifically adapted to anti-aircraft defence." He added:

"It is entirely within our capacity to guard all vulnerable approaches to the North American continent with interceptor-squadrons and guided missiles armed with atomic warheads, and to have these warheads in such profusion that an enemy seeking to penetrate our defences would confront a barrier of atomic firepower."

British United Press, Reuter, and
Associated Press.

Atomic Energy

12.

27 SEP 1948 59 CABINET REGISTRY

S E C R E T

HEAT AND POWER FROM NUCLEAR ENERGY

Summary of Conclusions

1. The chief application of recent nuclear discoveries will in all probability take the form of central generation of electricity and steam from heat released by stationary "atomic piles". (§ 2)

2. A fission chain reaction based on uranium or thorium is the only likely method of releasing nuclear binding energies. (§ 3)

3. The rare uranium isotope U235 is the only material known to occur in nature with fission characteristics which will produce a self-supporting chain reaction. (§ 4)

4. Present practice involves slowing down the fast neutrons emitted at fission to thermal velocitites, by including a "moderator" in the "atomic pile". (§ 4)

5. Natural uranium and thorium exposed to thermal neutrons emitted in the course of a fission chain reaction, produce even more fissile materials, known as plutonium and U233 respectively. (§§ 4 and 5)

6. Fission of U233 surrounded by thorium breeds more fresh U233 than the amount consumed, enabling the stock of fissile material to be increased and the natural thorium to be wholly consumed. (§ 5)

7. Fast neutron fission in uranium and thorium promise further but less certain possibilities of breeding fissile material and wholly consuming the natural metals. (§ 6)

8. Compared with a potential world output of 3,000 tons a year, 100% consumption of 19 tons of thorium per annum would release enough heat to replace all existing sources of energy in Great Britain. (§ 7)

9. Several thousand tons of thorium are however required as an initial working stock. (§ 7)

10. Assured world supplies of uranium may, on the other hand, not yield more than 8.5 tons of plutonium (=6.8 tons of U233) altogether. (§§ 8 and 9)

11. Although only equivalent to world energy requirements for a fortnight, this small supply of fissile material is ample to initiate breeding in thorium for large-scale supplies. (§ 9)

12. This places great importance upon the rate at which U 233 can breed; it is calculated to be capable of doubling every 2 to 4 years. (§ 10)

13. Such a rapid breeding rate makes the acquisition of small early supplies of plutonium (or U235) very much more important than big later supplies. (§ 11)

14. At that breeding rate, Great Britain could replace all existing energy supplies and increase them 33% by 1961 to 1970, if 1000 kilos of fissile material were provided over a five year period commencing in 1950.

15. Such a rapid build-up would only be achieved in practice if the highly specialised personnel and capacity required were planned far ahead on the most comprehensive scale. (§ 12)

16. Military requirements for a large stock and continuing supply of fissile materials for atomic explosives, far from competing with the claims of useful energy production, can in fact only be realised as part of a comprehensive nuclear energy system. (§ 13)

17. Power piles designed to ensure the speediest build-up of fissile material will be less economic than those suitable when peak output has been reached. (§ 14)

18. Atomic piles for generating power will have short lives, proportional to their total output, owing to the effects of radio-activity. This means that all atomic costs will in effect be current costs; so no large initial capital outlay will be involved in the establishment of an atomic system, apart from the cost of changing the channels through which energy is distributed and used. (§ 15).

19. Very rough calculations suggest that the generation share of nuclear energy costs per unit might be two-thirds that of a coal-fired system at current prices, which would reduce total delivered unit costs about one-quarter. (§ 18).

20. The chief effect upon energy costs would be through the stimulus which nuclear energy supplies would give to the adoption of a comprehensive electricity/district-steam system, which together with the direct gain of cheaper generation might reduce present average unit costs of all forms of energy by three-fifths (from $\frac{1}{2}$ to $\frac{1}{5}$ pence/KWH). (§§ 18 and 19, and Appendix D).

21. The consequent stimulus to modernisation in industry, and the related up-grading of the average skill of workmen, would contribute most markedly to the increase of national productivity and living standards. (§§ 20 and 21).

22. The coal industry would be converted from a grave source of weakness into a small and efficient source of exports and raw material for synthetic products. (§ 22).

23. Cheap power would encourage many new extractive and manipulative processes, which will make this country less dependent on foreign supplies, and able to compete more effectively abroad as well as to live better at home. (§ 23).

24. Great economies in transport and improvements in location of industry would be secured by a nuclear energy system; and the elimination of smoke would represent a substantial further external economy. (§§ 24 and 25).

25. An authoritative assessment of the technical possibilities and economic implications of nuclear energy should be put in hand on a continuing basis without delay. (§§ 26 and 27).

chain reaction is the rare uranium isotope U235, which is 1 part in 140 of natural uranium. However, in the course of this U235 reaction, the predominant uranium isotope U238 is converted into the new element plutonium when it absorbs slow neutrons, and plutonium has a neutron emission behaviour even better than that of U235. Nearly 4 atoms of plutonium are produced, for every 5 of U235 fissioned, and being a chemically distinct element it is much more readily separated from U238 than is U235. Separation of pure fissile material (plutonium or U235) is necessary to make atomic bombs, and it greatly facilitates the establishment of chain reaction systems to produce useful power. The object of the present type of primary atomic pile constructed of natural uranium is simply to produce plutonium in place of U235, primarily in order to avoid the very elaborate and costly isotope separation of the latter on a very large scale. These primary piles have not been designed to operate at a temperature high enough to produce useful energy. War-time practice used up only 2% of the U235 put into the pile (1/7000th of the uranium), and even now only 5% can be consumed in a single cycle. But the substantial stocks depleted to this small extent can be much more fully exploited by recycling methods now in course of development.

5. Natural thorium cannot initiate a self-supporting chain reaction. But if it is exposed to surplus neutrons emitted by U235 or plutonium chain reactions, their capture after being slowed down converts the thorium into another highly fissile isotope of uranium, U233. In natural uranium piles U233 can only be produced at a rate of 10-15% of the amount of U235 fissioned. But in piles constructed with uranium in which the U235 content has been enriched by partial isotope separation, much higher rates can be achieved. And in a pile constructed with pure plutonium, a rate as high as 80% is possible; this arrangement is known as a converter pile. When enough U233 is brought together to establish a chain reaction, it releases more neutrons per fission (apart from captures in the fissile material not producing fission) than U235 or plutonium, and can produce between 1.10 and 1.25 new atoms of U233 from thorium for each atom fissioned, allowing for the proportion of neutrons likely to be lost in the process. So the stock of U233 can be made to grow or breed, and the natural thorium from which it breeds can be wholly consumed. It is this process which provides the most certain key to large-scale power production by nuclear energy.

6. An alternative chain reaction system is possible, in which fission would be produced without slowing down the neutrons. This might permit a large proportion of natural uranium (or thorium) to be consumed, because fast neutron fission would emit a sufficient surplus of neutrons to produce breeding of plutonium from U238 in the same way as with U233 from thorium. This process represents an important possibility; but, unlike the slow fission breeding of U233, it is by no means yet a firm prospect. Fast fission may offer very high breeding rates (1.3 new atoms for each atom of U235 consumed, and 1.6 with plutonium); but heat extraction rates are likely to be much lower than with slow fission of U233, which probably means a slower accumulation of fissile material. Another related possibility is fast neutron chain reactions in pure plutonium or U233, by producing concentrations larger than the critical size for very short periods.

Raw Material Supplies

7. In order to give some indication of quantitative orders of magnitude, the weight of thorium which would have to be consumed to replace existing sources of energy may be

Recommendation

27. An authoritative study of the technical prospects, cost and economic implications of a comprehensive steam and electricity system based on nuclear energy should be undertaken without delay, on a continuing basis. Such a study might be initiated by giving the present memorandum a wide official circulation in a suitably revised form.

Cabinet Office, S.W.1.

??TH SEPTEMBER, 1946

APPENDIX A

RATE OF ACCUMULATION OF U233 BY BREEDING IN THORIUM

1. One atom of U233 emits 2.60 neutrons at fission, or 1.6 extra neutrons after allowing for replacement of the neutron which caused the fission. Between 0.18 and 0.30 of these extra neutrons are absorbed in U233 without producing fission and 0.17 to 0.20 are lost to the structure of the pile or escape. So between 1.10 and 1.25 neutrons remain to produce new atoms of U233 in thorium. The stock of U233 is therefore increased 10-25% each time it is consumed.

2. A heat-release rate of 10 MW per kilo of U233 in the pile is expected to be possible in a helium-cooled beryllia-moderated sandwich-type pile. Consumption of one kilo of U233 releases 20,000 MWH of heat. The time for complete consumption is therefore 2000 hours.

3. Something approaching half of the U233 stock may be tied up in chemical separation at any time, and an operating load factor of say 80% must be allowed for U233 in the pile to cover periodic interruptions. The U233 will therefore only be actually cooking 40% of the time so it will take 2000 ÷ 0.40 = 5000 hours for complete consumption. In other words, there will be 1.75 turnovers per annum.

4. With 10-25% increase on 1.75 turnovers, the stock will be increased between 17½% and 43½% in one year. If these values are rounded to probable limits of 19% and 41%, they may be expressed as doubling in 2 to 4 years.

5. The actual value will depend largely upon the exact number of neutrons lost per fission (0.35 to 0.50), and the extent to which the 40% cooking time may be improved in practice.

F54

10, Downing Street,
Whitehall.

MOST SECRET

MR. ARMSTRONG

I attach a copy of the draft letter to President Truman about the Atomic Bomb in its latest form. The Prime Minister wishes this to be circulated first to the Ministers who attended the Meeting on August 29 for their comments on the general line of approach. Will you please arrange this?

[initials]

September 6, 1945.

1. Sir E Bridges - to see
2. ~~Mr Pickett~~ - for action

[initials] 6/9

ANNEX

Draft Letter from the Prime Minister to President Truman

Ever since the U.S.A. demonstrated to the world the terrible effectiveness of the atomic bomb I have been increasingly aware of the fact that the world is now facing entirely new conditions. Never before has there been a weapon which can suddenly and without warning be employed to destroy utterly the nerve centre of a great nation. The destruction wrought by the Germans through their air fleet on Warsaw and Rotterdam was startling enough, but subsequent attempts to do the same to London were defeated though without much to spare. Our own attacks on Berlin and the Ruhr resulted in the virtual destruction of great centres of industry. In Europe the accumulated material wealth of decades has been dissipated in a year or two, but all this is not different in kind from what was done in previous wars in Europe during the Dark Ages and the Thirty Years war, in America by your own civil war. Despite these losses civilisation continued and the general framework of human society

and...

and of relations between peoples remained. The emergence of this new weapon has meant not a quantative but a qualitative change in the nature of warfare.

Before its advent military experts still thought and planned on assumptions not essentially different from those of their predecessors. It is true that the conservative (with a small c!) mentality tended to maintain some of these although they were already out of date. For instance we found at Potsdam that we had to discuss a decision taken at the Crimea Conference as to the boundaries of Poland. These were delimited by rivers although the idea of a river as a strategic frontier has been out of date ever since the advent of air warfare. Nevertheless it was before the coming of the atomic bomb not unreasonable to think in terms of strategic areas and bases although here again it has seemed to me that too little account has been taken of the air weapon.

Now, however, there is in existence a weapon of small bulk capable of being conveyed on to a distant target with inevitable catastrophic results. We can set no bounds to

the...

the possibilities of airplanes flying through the stratosphere dropping atomic bombs on great cities. There are possible developments of the rocket for a similar purpose. I understand that the power of the bombs delivered on Nagasaki may be multiplied many times as the invention develops. I have heard no suggestion of any possible means of defence. The only deterrent is the possibility of the victim of such an attack being able to retort on the victor. In many discussions on bombing in the days before the war it was demonstrated that the only answer to the bomber was the bomber. The war proved this to be correct. This obvious fact did not prevent bombing but resulted in the destruction of many great centres of civilisation. Similarly if mankind continues to make the atomic bomb without changing the political relationships of States sooner or later these bombs will be used for mutual annihilation.

The present position is that whilst the fundamental scientific discoveries which made possible the production of the atomic bomb are now common knowledge, the experience of the actual processes of manufacture and knowledge of the solutions which were found to the many technical problems which...

which arose, are confined to our two countries and the actual capacity for production exists only in the United States. But the very speed and completeness of your achievement seems to indicate that any other country possessing the necessary scientific and industrial resources could also produce atomic bombs within a few years if it decided now to make the effort. Again, our two Governments have gone a long way in securing control of all the main known sources of uranium and thorium, the two materials at present believed to be of importance for the process. But new sources are continually coming to light and it would not be surprising if it were found that large deposits existed in parts of the world outside our direct or indirect control. Nor may it be altogether easy to defend the measures which we have already taken in this matter when they become known and are considered in the light of such principles as that of the freedom of access to raw materials.

It would thus appear that the lead which has been gained as a result of the past effort put forth in the United States may only be temporary and that we have not

much ...

much time in which to decide what use is to be made of that lead. It is true that other countries, even if they succeed in producing atomic bombs, may not, at any rate at first, be able to produce them on the same scale. I am told, however, that, in future, it may be possible for the process to be developed at a far smaller cost in industrial resources than has inevitably been demanded by your pioneer enterprise, carried through in time of war when speed was the first essential; and in any case, with a weapon of such tremendous destructive power, it is perhaps doubtful whether the advantage would lie with the possessor of the greatest number of bombs rather than with the most unscrupulous.

A further consideration which I have had in mind is that the successful manufacture of bombs from plutonium shows that the harnessing of atomic energy as a source of power cannot be achieved without the simultaneous production of material capable of being used in a bomb. This means that the possible industrial uses of atomic energy cannot be considered separately from its military and security implications.

It ...

It is clear to me, therefore, that, as never before, the responsible statesmen of the great Powers are faced with decisions vital not merely to the increase of human happiness but to the very survival of civilisation. Until decisions are taken on this vital matter, it is impossible for any of us to plan for the future. Take the case of this country. During the war we had to shift our industry to the less exposed parts of our island. We had to provide underground shelters for our people. Now we have to restart our industries and rebuild our wrecked homes. Am I to plan for a peaceful or a warlike world? If the latter I ought to direct all our people to live like troglodytes underground as being the only hope of survival. I have to consider the defence forces required in the future in the light of San Francisco, but San Francisco did not envisage the atomic bomb. Its conceptions of security are based on appreciations of a situation existing in June of this year. We considered regional security and a policing of the world by the Powers with the greatest resources in the interests of all so that there should be available the forces to prevent aggression.

I ...

I have only mentioned Great Britain as an example; for every Head of Government must, in varying degree, find himself confronted with the same problems.

In these circumstances while realising to the full the importance of devising means to prevent as far as possible the power to produce this new weapon getting into other hands, my mind is increasingly directed to considering the kind of relationship between nations which the existence of such an instrument of destruction demands. In your country and ours resort is not had to violence not just because we have efficient police forces but because the vast majority of our citizens are law abiding and conditions are such that men are not driven to have recourse to desperate measures. Our constitutions allow of peaceful change.

We have it seems to me if we are to rid ourselves of this menace to make very far reaching changes in the relationship between States. We have in fact in the light of this revolutionary development to make a fresh review of world policy and a new valuation of what are called national interests. We are ourselves attempting to undertake such a

review ...

review. What was done on American initiative at San Francisco was first step at erecting the framework of a new world society, but it was necessarily tentative, having regard only to the requirements imposed by the technical advances in methods of warfare then known. Now it seems to us that the building, the framework of which was erected at San Francisco, must be carried much further if it is to be an effective shelter for humanity. We have to secure that these new developments are turned to the benefit rather than to the destruction of mankind. We must bend our utmost energies to secure that better ordering of human affairs which so great a revolution at once renders necessary and should make possible.

To proceed on these lines would inevitably involve risks whatever guarantees might be sought and given in advance. To the countries possessing the temporary advantage it would, therefore, constitute, in some degree, an act of faith, justified only if the risks of not so proceeding are in fact greater. I realise fully that for you, who have expended such vast resources on the project,

such ...

such an act of faith would be even more difficult than for us. I am therefore most anxious, before we proceed much further with our own deliberations, to know how your mind is moving; and it is primarily for this reason that I have set before you at such length my tentative views before they have really begun to crystallise.

Mr. Byrnes may, I hope, be able to tell us something of your plans when we welcome him in London but, later on, I think it may be essential that you and I should discuss this momentous problem together so that we may agree what the next step should be and be in a position to take it before the fears and suspicions which may be developing elsewhere have got such a firm hold as to make even more difficult any solution we may decide to aim at.

The President of the United States of America.

Spare.

F 54

TOP SECRET

DRAFT

I have set out below some reflections about the significance of the atomic bomb on which I should very much like to have your views.

Everyone will agree that this discovery raises major questions of world policy which are not only of the most far reaching importance in themselves, but are also fundamental, in the sense that upon the answer to them will depend unnumerable decisions in every sphere of civil and military planning. It will be recognised that the emergency of this weapon radically alters the whole foundation of our defence policy. Questions of bases, and frontiers, of air raid precautions and the strategic distribution of industry must all be looked at in a new light. In the field of foreign affairs, too, we are discussing every day questions many of which have largely lost their meaning, or at any rate have assumed an entirely different complexion, as a result of this discovery.

It is therefore of great importance that, on the one hand, our military staffs should begin to consider as soon as possible what this new influence means in terms of our future plans for defence and world security. To do this it will be necessary to arrive at some agreed interpretation of the present effects and future potentialities of the bomb as a weapon, and I hope that our scientific and military experts will co-operate together in working out the answers.

But behind these purely military aspects there lies the wider question of international policy upon which everything else depends. Much thought has, I know,

been given on your side to these questions as it has on ours, and in your statements over the radio and to Congress after the bomb had been dropped you expressed your determination that this immense new force in world affairs should be controlled, and should be devoted to the service and not to the destruction of mankind. I welcomed that statement and offered the full co-operation of His Majesty's Government to that end.

We have been giving some thought to the matter here and are anxious to know how your ideas are developing. It seems to us that the fundamental issue concerns the best use which can be made of the position of advantage at present held by those governments who have shared in the enterprise. We start from the assumption with which we take it you would agree, that we could not hope, even if we wished, to maintain indefinitely the sole control of this weapon. It must be expected that whatever we do other countries will develop the technique, perhaps within a few years, and will learn how to produce bombs even though they may not for some time be able to produce them on so large a scale. America may, through her early start and her great resources, be able to maintain the lead both in the production of the present weapon and possibly also in the development of new types. But there is always the possibility of new discoveries which will reduce the present advantage.

Then there is the question of raw materials. Our two Governments have gone a long way in securing effective control of all the important sources of uranium and thorium, the two materials which we at present believe to be of importance for the process. But we do not know what other sources may exist in the world. Only the other day our geologists told us of extensive deposits in Sweden. Now it seems there may be important quantities

in South Africa. It would certainly not be surprising if large deposits were found to exist in parts of the world outside our control. We may well find also that the steps we have taken and are still taking to secure control of all the important sources may be criticised. We are at this moment asking Sweden to take a difficult decision in promising to sell to us and to us only any uranium which she may produce.

Then again I am told that in the future it may be possible for countries to develop this process at a far smaller cost in industrial resources than has been inevitably demanded by your pioneer enterprise, carried through in time of war when speed was the first essential.

The successful manufacture also of bombs from Plutonium shows that the possible industrial use of atomic energy as a source of power cannot be separated from its military use, and this may ultimately have a considerable bearing on our problems.

The position seems to be, therefore, that while at present we hold a position of advantage, we must expect that other countries will try to overtake us in the future. In the meantime they may ask us either to impart the secrets to them or to supply them with materials. You will have heard that the Russians have already made enquiries of the Canadian Government about a possible purchase of a small quantity of uranium. It seems important to consider how these and similar requests should be met. I share your view that we can only disclose to other governments more than has already been published to the world, if that disclosure can be made a part of some effective arrangement for bringing this weapon under proper control. But I am sure you would agree that we should lose no time in considering what form such a system might take, in order that, if such a

thing can be devised, we may not necessarily arouse suspicion and fear amongst others that we intend to keep this weapon to ourselves and use it as a threat against them.

I feel sure that we neither of us underrate the difficulties. I must confess that I find it hard at present to see what sort of agreement could be proposed which would effectively prevent the development of this weapon by those who have the necessary resources. Would any system of international inspection be practicable? Should we ever be able to penetrate the curtain which conceals the vast area of Russia? If not, is not some wider approach necessary based on the work so hopefully begun at San Francisco which must be extended and carried further? Or are we to rely on the hope that if we are more strongly armed in this way than others, so that an atomic bomb on one of our great cities can be answered by instant and overwhelming retaliation, these terrible weapons may never have to be used at all? That would indeed be a precarious foundation on which to have to build our plans for the future.

These are some of the questions to which we have still to find an answer, but to which an answer is urgently needed. I hope that Mr. Byrnes may be ready to discuss them with us when he comes to London and may be able to tell us in what direction your mind is moving. Later on I think it may be essential that you and I should discuss them together so that we may be ready to talk them over with Marshal Stalin.

This position faces every Head of State in Europe and in the whole world. At the present time the secret of the manufacture is held by our two countries and the machinery for production by your country.

Here would follow the account of the steps taken to deal with raw materials, etc.

It would then be added that, so far as our scientists can see, other nations will be able to learn the secret.

We have therefore only a short period of a few years in which we can take steps to control the position.

We do not believe that the matter can be dealt with by inspection in a world of potentially warlike states. Machinery by which the matter must be dealt with and controlled is therefore world organisation.

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File Number

59

PART 2.

Previous Reference

PART 1.

For Cross References see inside of Cover.

THERMO-NUCLEAR WEAPONS.

POLICY AND RESEARCH.

Referred to	Date	Referred to	Date	Referred to	Date
Mr K. L. Stock.	22/2/55.			PLEASE RETURN TO CENTRAL WAR PLANS' SECRETARIAT. DATE	
~~Sir N. Brook~~	25/2/55				
Registry	28/2/55				
~~Mr J. K. Stock~~	4/3				
Sir Norman Brook Pa	5/3/55.				
Sir N. Brook.	10/3/55				
Mr J. Martin	26/4/55				
~~Registry~~	~~14/11~~				
~~Mr Roberts~~ Pa	~~4/1/56~~ 9/1				

Files Containing Matter Bearing on this Subject.

FILE NO.	SUBJECT
59	Thermo-nuclear weapons. Policy and research.
59/A	Hydrogen bomb. Codeword For:
59/B	Thermo-nuclear weapons. Miscellaneous Hansard and Press cuttings.
59/1	Atomic Energy: Industrial uses.
59/5	Atomic Energy. Collaboration with the United States on research and development.
59/16	Atomic weapons. Storage of:
12/4/90	Armed Forces. Problems of: in the initial phase of a war.
15/34/66	Location of the seat of Government in war.
19/10/205	Defence plans of the Service Departments.
19/10/205/1	Review of Defence Expenditure.
19/10/262	Defence plans of the Civil Departments.
19/10/262/1	Defence plans of the Civil Departments. (British Broadcasting Corporation).
19/10/263	Stockpiling preparations for war.
2/5/74	Civil Defence Services: Organisation.
4/5/60	Central War Plans Secretariat. Functions.
2/1/5	Civil Defence. Evacuation policy.
2/1/8	Civil Defence. Production of civilian respirators.

86th Congress } 1st Session } JOINT COMMITTEE PRINT

BIOLOGICAL AND ENVIRONMENTAL EFFECTS OF NUCLEAR WAR

SUMMARY-ANALYSIS OF HEARINGS

JUNE 22–26, 1959

JOINT COMMITTEE ON ATOMIC ENERGY

CONGRESS OF THE UNITED STATES

AUGUST 1959

Printed for the use of the Joint Committee on Atomic Energy

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CONTENTS

ERRATUM

On page 8, beginning at the 12th line from the bottom, the paragraph should read:

"Probably the most significant finding presented to the subcommittee was that civil defense preparedness could reduce the fatalities of the assumed attack on the United States from approximately 25 percent of the population to about 3 percent. The provision of shielding against radiation effects would at the same time protect against blast and thermal effects for the vast majority of the population."

44501°—59

The resources of the Atomic Energy Commission, its personnel and unclassified publications, were made available by Chairman McCone and were of great value to the subcommittee.

The subcommittee also utilized a mass of unclassified data furnished by other governmental and private sources on the effects of radiation. A special mention of appreciation is due Dr. Paul Tompkins and his associates of the U.S. Naval Radiological Defense Laboratory. Much of the basic data presented at the hearings was derived from the work of the USNRDL, and Dr. Tompkins and his staff consulted freely with the subcommittee throughout the hearings and during the preparation of this report.

The witnesses presenting testimony were selected on the basis of their competence and experience in the different fields of nuclear phenomena, with particular emphasis on nuclear weapons effects.

In the biomedical field the subcommittee received testimony from those scientists and technical personnel having the broadest experience in laboratory work on test animals and in the treatment of human beings exposed to radiation at Hiroshima and Nagasaki and in the accidental contamination of the Marshall Islands.

For the consideration of structural damage from blast and fire and of other weapons effects, outstanding authorities presented their findings and the latest available scientific data.

The weather patterns and other meteorological data for the date of the hypothetical attack were established by experts of the U.S. Weather Bureau, supported by their worldwide organization.

The reader is encouraged to examine the full testimony and supporting data of each witness in the printed record of the hearings. In this report the subcommittee has endeavored to present a faithful and concise summary of the data and to highlight the key issues for the convenience of the public and the Congress. Naturally, these data and issues are more completely set forth in the verbatim hearing record.

II. Summary

THE HYPOTHETICAL ATTACK

The hypothetical attack set forth by the subcommittee assumed that 263 nuclear weapons in 1, 2, 3, 8, and 10 megaton sizes with a total yield of 1,446 megatons [5] were detonated on 224 targets within the United States. An additional 2,500 megatons were assumed to have been detonated elsewhere in the Northern Hemisphere in attacks on overseas U.S. bases and in retaliation against the aggressor homeland. All weapons were arbitrarily designated as having a yield of 50 percent fission and 50 percent fusion. A weapon with 50 percent fission yield is one in which 50 percent of the total energy (yield) is derived from the fission process. Nuclear fission refers to the splitting of heavy atoms such as uranium and is the primary source of contamination of radioactive fallout particles.

[5] A 1-megaton bomb has the same explosive energy release as 1 million tons of TNT. The Hiroshima bomb yield was estimated at 20,000 tons of TNT, or 20 kilotons.

CASUALTIES AND DAMAGE TO DWELLINGS

The expert testimony and supporting scientific data presented at the subcommittee hearings indicate that under present conditions such an attack would have cost the lives of approximately 50 million Americans, with some 20 million others sustaining serious injuries. More than one-fourth (11.8 million) of the dwellings in the United States would have been destroyed and nearly 10 million others would have been damaged. Some 13 million additional homes would have been severely contaminated by radioactive fallout. Altogether, approximately 50 percent of existing dwellings in the United States would have been destroyed or rendered unuseable for a period of several months.

Although the weapon detonations used in this exercise were designated as surface bursts, which would maximize the local radioactive fallout hazard, nearly 75 percent of the deaths would have resulted from the blast and thermal effects, combined with immediate radiation effects. Only 25 percent of all fatalities would have resulted from fallout. At the same time, more than half of the surviving injured would have radiation injuries.

Most of the damage sustained by dwellings would have resulted from the blast and thermal effects.

BIOLOGICAL EFFECTS

The three casualty-producing phenomena of nuclear weapons—blast, thermal, and radiation—occur in varying combinations, depending on proximity to the point of detonation. At close range one would encounter all three, including fallout radiation as well as immediate radiation from the fireball.

1. *Blast effects*

Blast produces primary effects resulting from the blast wave itself (lung damage, rupture of eardrums); secondary effects, resulting from flying fragments (loose debris, building materials) propelled with great force by the blast wave; and tertiary effects, resulting from the body itself being thrown violently by the blast wave. In addition, miscellaneous injuries will result from conditions created by the blast on surrounding objects (e.g., broken gas mains, downed power lines).

Approximately 95 percent of the blast casualties produced by a 10-megaton weapon will result from the secondary and tertiary blast effects. For this size weapon the secondary effects are important to a distance of 11 miles; the tertiary effects can occur to distances of from 7 to 16 miles.

2. *Thermal effects*

Thermal effects consist of fires caused by direct ignition of combustible materials, skin burns on exposed portions of the body, and temporary or permanent blindness from the intense light of the fireball.

In the hypothetical attack situation posed by the subcommittee, thermal effects, including the hazard of mass fires ("fire storms"), could extend over large areas, in some cases up to distances of 20 to 25 miles from the point of detonation.

3. Radiation effects

The most severe form of radiation injury, under conditions of nuclear war, would be that resulting from severe exposure to the primary radiation "flash" (close to ground zero) or that attending whole body exposure to close-in fallout during the first day or so. However, severe irradiation could occur as a result of prolonged exposure to local fallout even after the first day unless survivors were provided with adequate shelter protection. Direct contamination of the skin with fallout debris could produce painful "beta burns" due to the action of beta rays irradiating the skin and outer layers of the body surface. In addition, there is an internal hazard of radioactive material which gains entry into the body through inhalation, ingestion, or through open wounds.

(1) *Acute effects.*—Instantaneous radiation doses of 5,000 roentgens or greater immediately produce symptoms of shock; death occurs within hours.

Radiation doses of 1,000 to 5,000 roentgens produce nausea and vomiting, fever and general fatigue within a few hours. Temporary recovery is followed within 1 or 2 weeks by reappearance of symptoms and probable death.

Exposure to doses of 200 to 1,000 roentgens causes nausea and vomiting within a few hours and in the period of from 2 to 4 weeks after exposure major changes will occur in the composition of the blood, rendering the body particularly susceptible to infections during this time. Approximately one-half of those exposed at the level of 450 to 700 roentgens would be expected to recover if not subjected to additional physical stress or radiation. The other one-half would die within 2 to 4 months. Probability of recovery increases greatly at levels below 450 roentgens.

Radiation doses of 200 roentgens or less will produce only mild symptoms of nausea and vomiting. Changes in the blood may occur later, but individuals so exposed usually will not require hospitalization.

(2) *Effects of protracted radiation.*—Higher radiation doses can be tolerated by the body without developing symptoms of acute radiation illness if exposure is spread over a longer period of time. Approximately 90 percent biological recovery can occur with continued or repeated exposures, but the remaining 10 percent nonrepairable injury may produce late effects, such as cancer, over a period 20 years or more.

When only a part of the body is exposed, the ability to recover is greatly increased. For example, the exposure of a person's legs alone to 500 roentgens of radiation would not result in a lethal dose.

The probability of increasing the incidence of leukemia and other types of cancer is considered proportional to the average total radiation dose sustained by the surviving population. Potential deaths from this cause are estimated as about 2 percent of the deaths attributable to acute radiation injury. These deaths will be spread out over a period of decades since it is a characteristic of radiation-induced cancer to be long delayed after incidence of injury.

(3) *Skin burns from fallout.*—Skin burns can be caused by beta rays from the fallout particles coming in direct contact with the skin. However, very large doses of beta radiation are required to produce severe burns, and the particles may be removed from the skin by good

fallout decontamination would be required to reduce the strontium 90 content of the soil to a level acceptable for production of some food crops and milk.

3. Long-term environmental effects

Although much remains to be learned about the long-range impact of a nuclear war on "the balance of nature," the concensus of the testimony was that, despite the severe shock, life would continue and full ecological recovery would eventually occur.

ADDITIONAL DATA ON RADIOACTIVE FALLOUT

Several additional factors presented to the subcommittee with respect to radioactive fallout are considered highly important.

(1) The worldwide strontium 90 fallout resulting from the assumed attack would not pose a major survival problem in countries not attacked. The level of strontium 90 deposited from long-term fallout would be higher than the maximum permissible concentration recommended for the population as a whole on a peacetime standard, but lower than the recommended maximum permissible occupational dose under controlled conditions.

(2) The actual release of gamma radiation energy from fission products differs significantly from that represented by the standard formula ($t^{-1.2}$ rule) contained in the official Government publication, "The Effects of Nuclear Weapons." New calculations indicate that early dose rates will be of greater intensity than previously believed and that over a long period of time the rate of decline will be more rapid. While the problem of immediate survival in a nuclear war is thus increased, the problem of long-term recovery is reduced.

(3) Local fallout is significantly affected by wind and weather. Actual fallout contours will differ markedly from the idealized cigar-shaped patterns normally used as a basis of estimating fallout effects. Moreover, peak fallout intensities will almost never occur at or near the point of weapon detonation. For example, the maximum fallout intensity for a weapon of a 5- to 10-megaton yield may appear at a distance as great as 60 to 70 miles from the point of detonation.

SURVIVAL MEASURES

Probably the most significant finding presented to the subcommittee was that civil defense preparedness could reduce the casualties of the assumed attack on the United States from approximately 30 percent of the population to about 3 percent. The provision of shielding against radiation effects would at the same time protect against blast and thermal effects for the vast majority of the population.

The cost of providing high-performance shelter protection for 200 million people was estimated at between $5 billion and $20 billion.

The main conclusion presented to the subcommittee was that the country must have a national radiological defense system if the Nation is to withstand and recover from an attack of the scale which is possible in an all-out nuclear war.

TABLE III—2.—*Targets of the attack*

Type of target	Number	Number of weapons	Weight (megatons)
Air Force installations	111	111	645
Critical target areas	71	110	567
AEC installations	21	21	168
Army installations	12	12	24
Navy installations	5	5	28
Marine Corps installations	4	4	14
Total	224	263	1,446

All weapons were arbitrarily designated as 50 percent fission and 50 percent fusion weapons detonated at ground level, that is, with the fireball touching the earth's surface. Each weapon was assumed to have been detonated at or near its specified target by using a standard statistical method for random bombing errors.

The total of 1,446 megatons was considered the yield of the weapons detonated, not the gross attack which the aggressor force might have launched initially, and no attempt was made to "war game" the overall problem of weapon delivery, interception, and retaliation.

For purposes of computing worldwide fallout and its effects for a period of 5 years after the attack, again without war gaming, it was assumed that 2,500 megatons of weapons were detonated on areas of the Northern Hemisphere outside the continental United States, representing the net result of attacks on U.S. overseas bases and U.S. retaliatory strikes against the aggressor homeland.

The general distribution of targets in the United States is illustrated on the map in figure III—1.

The time of the hypothetical attack was set at 12 noon Greenwich time (7 a.m. eastern standard time) on a typical October day, which assumes completed harvest and storage of food crops in the aggressor homeland. The actual weather conditions used in plotting fallout patterns and determining the effects of meteorological factors were those recorded for October 17, 1958, a typical fall day. It was necessary to select a particular day in the past in order to provide the weather data for accurate calculations.

IV. Basic Effects of Weapons Employed

As indicated above, the weapons employed in the hypothetical attack assumptions consisted of 50 percent fission and 50 percent fusion weapons ranging in size from 1 to 10 megatons, all detonated at ground level. The following data concerning the basic effects of these weapons were presented at the subcommittee hearings. Later sections of this report will discuss the biological and environmental effects of these weapons in greater detail.

1. *Partition of energy in a nuclear explosion*

About 35 percent of the total energy of a nuclear explosion is given off as radiant thermal energy or heat, in much the same way as the sun radiates heat. Another 50 percent of the bomb energy is contained in the blast wave that travels several times the speed of sound. About

SUMMARY OF EFFECTS FOR 1-MEGATON AND 10-MEGATON NUCLEAR WEAPONS

Blast, which is primarily a damaging agent to inanimate objects such as buildings, produces flying debris which is a hazard to man. The cratering effects result in the destruction of even deep underground structures.

Thermal radiation damages both humans and combustible structures and materials.

Nuclear radiation, including both the initial and residual fallout are primarily hazards to man and animals.

The distances and areas covered by various effects are contained in the following table:

TABLE IV-1.—*Summary of effects of the assumed nuclear weapons 1 to 10 megatons*

	1 megaton	10 megatons
A. Inanimate objects:		
1. Crater (dry soil)	Radius, 650 feet; depth, 140 feet.	Radius, 1,250 feet; depth, 240 feet.
2. Brick apartment houses collapse.	Radius, 3 miles	Radius, 7 miles.
3. Ignition of light kindling materials.	Radius, 9 miles	Radius, 25 miles.
B. Man:		
1. Blast injury (flying debris)	Radius, 3 miles; area, 28 square miles.	Radius, 7 miles; area, 150 square miles.
2. 2d degree burns on bare skin	Radius, 9 miles; area, 250 square miles.	Radius, 25 miles; area, 2,000 square miles.
3. Initial nuclear radiation (700 rem).	Radius, 1.5 miles; area, 7 square miles.	Radius, 2 miles; area, 12.5 square miles.
4. Fallout, 15-knot winds (450 rem in 48 hours, no shielding).	40 miles downwind; 5 miles crosswind; area, 200 square miles.	150 miles downwind; 25 miles crosswind; area, 2,500 square miles.

V. RADIOACTIVE FALLOUT PATTERNS, PHYSICAL DAMAGE AND CASUALTIES IN THE UNITED STATES

Based on the specific attack assumptions developed by the subcommittee, the Office of Civil and Defense Mobilization prepared a damage assessment with respect to blast, thermal, and fallout effects on dwellings and people during the period of 90 days following the attack.

While the primary effects of nuclear explosions may claim the greatest number of victims, the threat of persisting radioactivity poses the greatest hazard to survivors. It was for this reason that the subcommittee devoted much of its investigation to the problem of radioactive fallout.

FALLOUT PATTERNS

The fallout situation plotted by the OCDM is depicted on the maps reproduced in figures V–1, 2, 3, 4 and 5 showing conditions at the postattack time periods of 1 hour, 7 hours, 2 days, 2 weeks, and 3 months.

These maps show the progression of fallout across the United States during the first 2 days postattack and then indicate its subsequent retreat as radiation decay begins to predominate over further deposition of fallout. At 1 hour post-attack less than 10 percent of the country is affected by fallout but the dose rates are very high, exceeding 3,000 roentgens per hour in some areas. By 7 hours,

force that can absorb an enemy blow and still strike back with adequate strength and, second, certain minimum nonmilitary protection for the civilian population.

TYPES OF DETERRENCE

It was also stated that even if the "balance of terror" theory were correct, the United States would still be faced with important strategic problems. As the witness pointed out, in 1914 and 1939, it was the British and the French who declared war on the Germans and not vice versa. It is difficult for Americans to realize that, under certain circumstances, neither the Soviets nor the Europeans might believe that the United States would come to the aid of Europe. In making this point, the witness asked the subcommittee to ponder a hypothetical situation in which American defenses were so weak and Soviet retaliatory forces so strong that if the United States responded to a Soviet ground attack on Europe the Soviet counterretaliation would kill all 177 million Americans. Under such conditions, the witness said, it would not be surprising if neither the Europeans nor the Soviets found the U.S. promise to come to the aid of Europe credible. But if it is true that the Soviets and the Europeans would not believe that we would honor our commitments to our allies if it meant 177 million American deaths, what level of casualties do they believe we would accept? It was stated that, to the extent that the Soviets believe we can keep our casualties to a level we would find acceptable, whatever that level may be, they will be deterred not only from attacking the United States directly, but also from very provocative aggressions, such as a ground attack on Europe. But, it was said, to the extent that they do not believe we can keep casualties to an acceptable level, the Soviets may feel safe in undertaking these extremely provocative military adventures.

In discussing this aspect of the strategic problem facing the United States, the witness distinguished between what he called Type I deterrence and Type II deterrence. Type I deterrence, which the British call "passive deterrence" on the assumption that it requires no act of will to initiate a response, is the deterrence of a direct attack. If the United States were directly attacked, its response would be automatic. Type II deterrence, which the British have called "active deterrence" is defined as the forces necessary to deter an enemy from engaging in military adventures short of a direct attack on the United States itself. There is a question as to how effective nuclear retaliatory forces would be as a Type II, "active" deterrent. In pondering this question, it must be assumed that before launching on such an extremely provocative adventure, the enemy would have alerted his own retaliatory forces and instituted protective measures for his population. By such precautionary measures, the Soviets, according to the witness, might limit casualties to 10 percent of its population and one-third of its wealth. This is just about what they suffered in World War II, from which they had recovered by 1951. If the Soviets believed that they could limit destruction to this extent and were also convinced that the United States had failed to take the measures that would similarly limit destruction in the United States, they might well feel free to launch an aggressive attack.

Put another way, the subcommittee was told, a very moderate shelter program, which would combine protection against fallout and some blast resistance, could reduce the expected casualties to approximately one-third of those who would die if there were no protection at all. A more extensive program, designed to protect persons in our urban areas, could reduce the overall fatalities of this attack from 25 percent of the population to approximately 3 percent.

Such measures were believed not to be terribly expensive. The subcommittee was told that the program of fallout shelters, which would go far toward saving the lives of the 60 percent of all Americans who do not live in or near target areas, is one which depends on simple tools and simple techniques. The lives of millions could be saved or lost by a simple choice. Thus, one eminent witness pointed out that on the basis of the 1954 thermonuclear detonation at Bikini, where the area of blast and thermal effects was perhaps 300 square miles (a circle with a radius of 9¾ miles), the total area of likely radiation casualties was approximately 7,000 square miles. Clearly, the subcommittee was told, it is the people in the intermediate 6,700 square miles about whom something could be done: "We can save them easily; we can lose them easily."

The burden of the testimony received on this point was that if such protective measures were taken, the impact of America's ability to survive a nuclear war would be so great that the likelihood of such a war would be vastly reduced. So long as the Soviets have the advantage of forewarning and can reduce their already low vulnerability through a comprehensive civil defense program, the United States will be at a marked disadvantage. Its firm foreign policy will be open to doubt and disbelief, and to possible blackmail.

Thus, it was suggested that our lack of a civil defense program could lead the Soviets to take a provocative step which we could not ignore, and a nuclear war would have started with no protection for the American people. Or, as a final paradox, the subcommittee was told, in a world of great tension the Soviets may be unable to believe that we would allow an aggressor to strike us first, which the theory of "massive retaliation" implies. The acceptance of such a military disadvantage as a basis for our national policy may seem foolish to them. They may therefore discount the sincerity of our position and expect instead that the United States actually intends to strike the first blow. A war which neither side wanted could thus break out because of our defensive weakness.

MAKESHIFT SHELTERS

Technische Anleitung für die Herrichtung von Behelfs schutzräumen (TA BSR 1977)

[Technical Instructions for the fitting-out of makeshift shelters (TA BSR 1977)]

SWISS FEDERAL AUTHORITY

OFFICE OF CIVIL DEFENSE

Psychological behaviour

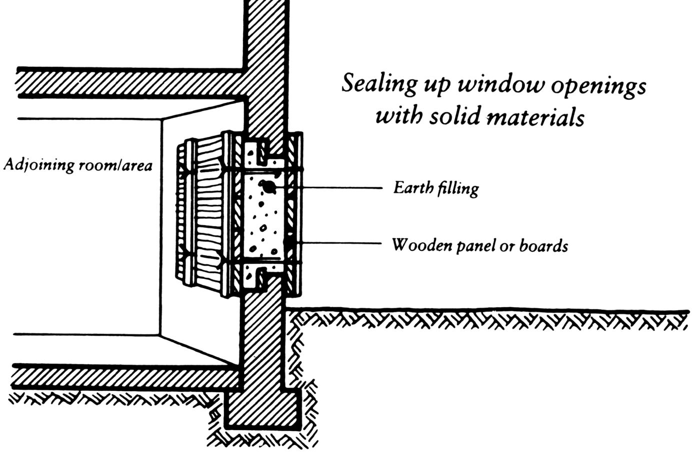
The *psychological behaviour* of man in crises and war is characterized:

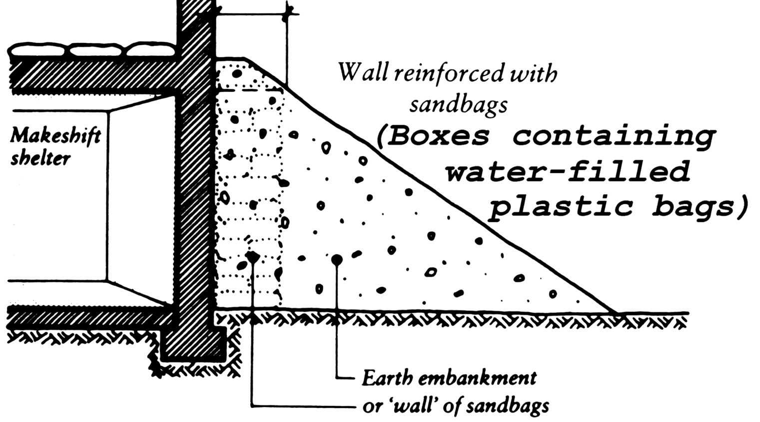
1. In peacetime
   - —by repressing fear of a possible war (or catastrophe),
   - —by grossly underestimating his ability to resist and survive,
   - —by ignorance of and missing confidence in modern protection systems against modern weapon effects,
   - —by taking insufficient precautions against wars and/or catastrophes.

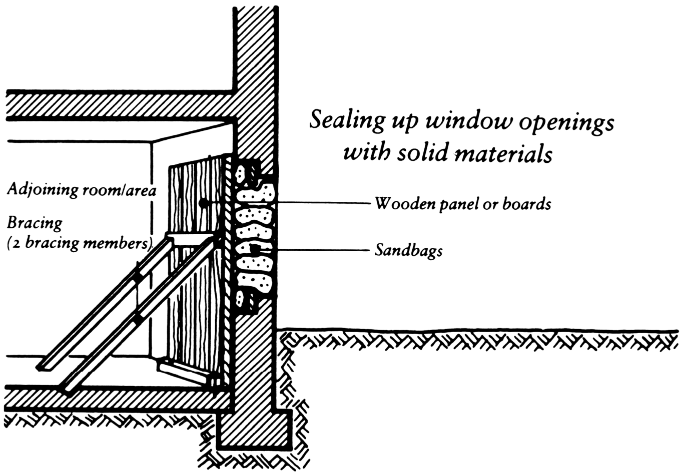
2. In the pre-attack phase
   - —first pre-attack phase
     - —by a reluctance of leadership to order the commissioning and occupation of shelters,
     - —by a reasonable behaviour of the population, provided there has been sufficient prior information on possible events,
     - —by rather unreasonable behaviour (but not panic) in case of inadequate information,
     - —by the readiness to occupy the shelters and stay there, if the population feels the danger and if the shelters are well built, equipped, and managed.

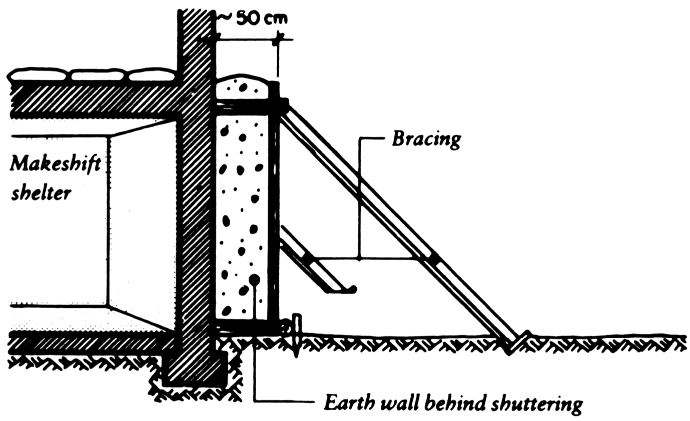
Swiss blast and fallout radiation shielding methods

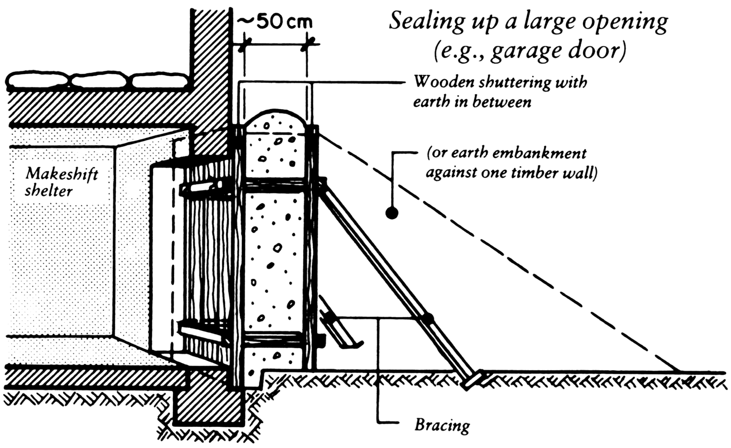
(Swiss Federal Authority Office of Civil Defence, Makeshift Shelters, TA BSR 1977.)

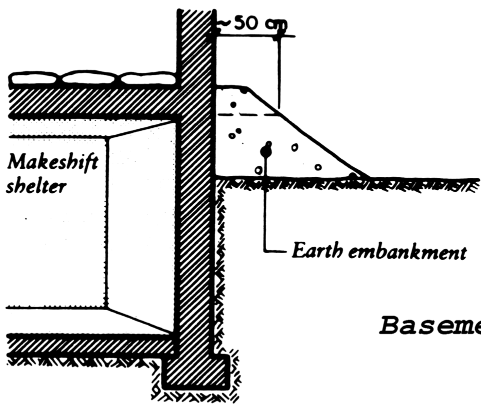












Basement improvement

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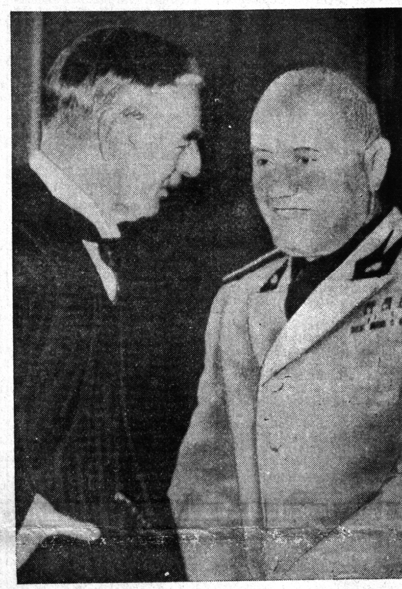

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Daily Express Staff Reporter

MR NEVILLE CHAMBERLAIN is likely to be offered a Knighthood of the Garter—the highest honour the King can bestow.

This would be in recognition of his services to the cause of peace.

Mr Chamberlain's half-brother, Sir Austen, was made a K.G. for his work in bringing about the Locarno Treaty.

The honour carries with it the title "Sir."

Although Mr Chamberlain would probably prefer to remain "plain Mr," as his brother wished to do, it has been ruled that the title must go with the honour.

London rejoices

PREMIER'S WIFE MOBBED

Crowds of women rejoicing at the news from Munich cheered Mrs Neville Chamberlain for several minutes last night as she left St Michael's Church, Chester Square, London, where the Archbishop of Canterbury had addressed a broadcast service.

As Mrs Chamberlain appeared at one of the doors after the service a great crowd were waiting to cheer her. By the time her car had arrived they had grown to several thousands.

As she stepped into the car they surged round cheering continuously.

Women with tears in their eyes grasped her hand and congratulated her on the good news.

Before the car could move away women clambered on the running-boards. As they pressed forward to grasp her by the hand Mrs Chamberlain, almost overcome by emotion, repeated: "Thank you. Oh, thank you."

Legion await order to police areas

THE British Legion are ready to send 8,000 ex-service men to act as a civilian police force in Czecho-Slovakia as soon as they learn that this service offered to Hitler by Major-General Sir Frederick Maurice, president of the Legion, has been accepted.

An official of the British Legion stated at 1.30 a.m. today:—

"It is within the realm of practical politics that we may be called in to police the districts subject of the dispute, but so far our offer has not been officially accepted."

After Sir Frederick Maurice's interview with Hitler it was stated that the Fuhrer's reception of the offer was "rather cool."

PLAN DISCUSSED

His reference to it in his speech at Berlin gave rise to hope, however, that he had come to consider it more favourably, and discussions were continued at British Legion headquarters of a plan for putting the scheme into operation.

It is proposed that the ex-service men who are to police Sudetenland shall have no uniforms, and carry no firearms.

An official stated that the number of officers required would be "certainly not in excess of 10,000." The legion are ready to send such a force abroad at very short notice.

"We are only waiting for the word 'Go,'" he added.

It is assumed that in the new circumstances of the Munich conference all four Powers concerned will have to approve the scheme.

War Loan leaps £115,000,000

And pound goes up

Prices continued to recover sharply all day yesterday on the London Stock Exchange. Most spectacular rise was that of 5¾ points, which put £115,000,000 on to the market value of War Loan.

Controllers of the British Exchange Equalisation Fund, who have kept ceaseless watch on the pound during the week in order to prevent a catastrophic fall, sat back in their chairs, did nothing all day.

Without any official support the pound moved up.

From Page One

TEXT OF PEACE TERMS—Official

Government bear the responsibility for seeing that the evacuation is carried out without damaging the aforesaid installations.

3. Conditions governing the evacuation will be laid down in detail by an international commission composed of representatives of Germany, the U.K., France, Italy, and Czecho-Slovakia.

4. The occupation by stages of the predominantly Sudeten German territory by German troops will begin on October 1. The four territories marked on the attached map will be occupied by German troops in the following order:—

The territory marked No. 1 on the First and Second of October, the territory marked No. 2 on the Second and Third of October, the territory marked No. 3 on the Third, Fourth, and Fifth of October, the territory marked No. 4 on the Sixth and Seventh of October.

The remaining territory of preponderantly German character will be ascertained by the aforesaid international commission forthwith, and be occupied by German troops by October 10.

5. The International Commission referred to in Paragraph Three will determine the territories in which a plebiscite is to be held.

These territories will be occupied by international bodies until the plebiscite has been completed.

The same Commission will fix the conditions with which the plebiscite is to be held, taking as a basis the conditions of the Saar plebiscite. The Commission will also fix a date not later than the end of November on which the plebiscite will be held.

6. The final determination of the frontiers will be carried out by the International Commission. This commission will also be entitled to recommend to the four Powers—Germany, the United Kingdom, France, and Italy—in certain exceptional cases minor modifications of the strictly ethnographical determination of the zones which are to be transferred without plebiscite.

7. There will be a right of option into and out of the transferred territories, the option to be exercised within six months from the date of this agreement.

A German Czecho-Slovak commission shall determine details of the option, consider ways of facilitating the transfer of population, and settle question of principle arising out of the said transfer.

8. The Czecho-Slovak Government will within a period of four weeks from the date of this agreement release from their military and police forces any Sudeten Germans who may wish to be released, and the Czecho-Slovak Government will within the same period release Sudeten German prisoners who are serving terms of imprisonment for political offences.

Annexe to the agreement:—

His Majesty's Government in the United Kingdom and the French Government have entered into the above agreement on the basis that they stand by the offer contained in Paragraph 6 of the Anglo-French proposals of September 19 relating to an international guarantee of the new boundaries of the Czecho-Slovak State against unprovoked aggression.

When the questions of the Polish and Hungarian minorities in Czecho-Slovakia have been settled, Germany and Italy for their part will give a guarantee to Czecho-Slovakia.

Second Annexe:—

The heads of the Governments of the Four Powers declare that the problems of the Polish and Hungarian minorities in Czecho-Slovakia, if not settled within three months by agreement between the respective Governments, shall form the subject of another meeting of the heads of the Governments of the Four Powers here present.

Supplementary declaration:—

All questions which may arise out of the transfer of the territory shall be considered as coming within the terms of reference to the International Commission.

Cities can follow London's two plans for evacuation

BILLETS WILL BE FREE

Daily Express Staff Reporter

THE Government scheme for the evacuation of people not taking part in the maintenance of national services in London and large cities in the event of war was announced last night.

Any one who cannot make private arrangements to go into the country will have the chance to be taken to billets in private houses some 50 miles from "danger areas."

Details of the plan apply to London, but indicate the lines to be followed by other centres.

There are two separate schemes.

1. A general evacuation in the event of emergency.

2. A special scheme for the evacuation of children by school groups.

The arrangements come into operation only when announced by the Government.

Here are the plans:—

Evacuation

When the Government give the order those who wish to get out should go to any of the stations announced as evacuation centres and not to any other station.

They should take their gas-masks and only small hand luggage. They should wear their warmest clothes and should take some food for the journey and a rug or blankets. No domestic animals can be taken.

At these "pick-up" stations refugees (as they are called in the Home Office circular) will be given a special free railway ticket. They will then be taken by train to a suitable destination between 30 and 50 miles from the centre of London.

Every one will be given at his destination a special franked post card so that he can write to his relatives giving his address.

Those coming off the trains will be met and billeted either at the places where they arrive, or in near-by towns or villages. Transport will be free.

At first the Government will pay for the billets, but later it is expected that those who can afford will contribute.

Food

At the railhead each refugee will draw a free ration of food for 40 hours, including canned milk. After that, refugees will be expected to buy their own food.

Financial help

Refugees in immediate need of money can apply to the nearest office of the Ministry of Labour and will have to present their billeting form.

The Government will pay to each householder taking a refugee 5s a week for adults and 3s for children under 14. The householder will obtain this payment on presentation to Post Offices of the billeting form which will be served on him.

Similar arrangements are being made for some of the big cities. In Scotland modifications will be made to meet local conditions.

For children

Schoolchildren who cannot go to relatives or friends can be sent away in the care of their teachers.

Arrangements have already been made at some schools. They will be extended if necessary.

Children will go to school as usual. They will be taken to the station by teachers or other adults connected with the school. They will be given free tickets and taken by special trains to stations about 30 to 50 miles from London. Homes will be found in private houses.

Householders will be expected to give them board and lodging and to look after them.

The Government will pay the householder 10/6 a week if one child is taken, and 8/6 for each additional child.

As far as possible groups from each school will be found homes near each other, and school teachers and others who have volunteered to help in looking after them will be in constant touch.

Parents who wish their children to go should note these instructions:—

1. The children should be sent to school as usual.

2. They should be dressed in their warmest clothes.

3. They should be given an overcoat or macintosh, hand luggage, a blanket, if possible food for the journey, and an apple or orange, but no drinks in glass bottles.

4. They should take gas masks.

Ordinary railway arrangements at these stations will be seriously interrupted during these hours—which will be roughly from ten o'clock in the morning to four o'clock in the afternoon.

The "Big Four" get together

CZECHS MA CON

Wall Street goes ahead

Daily Express Staff Reporter

NEW YORK, Thursday. — Encouraged by news from Munich, New York's stock market advanced steadily today, prices rising one to four points.

There was a slight setback at noon, but this was overcome when reports were received that the Powers had agreed over Sudetenland.

Sales totalled 1,000,000 shares.

IT was learned i the Czech G concessions.

A communiqué sta Czechs were prepar Germany territor more than 50 p German inhabitant for itself only fron kind as to make the Slovak State capable and defence

page 5: top centre photo of Prime Minister Chamberlain, Daladier, Hitler & Mussolini

FRIDAY, DAILY EXPRESS SEPTEMBER 30, 1938

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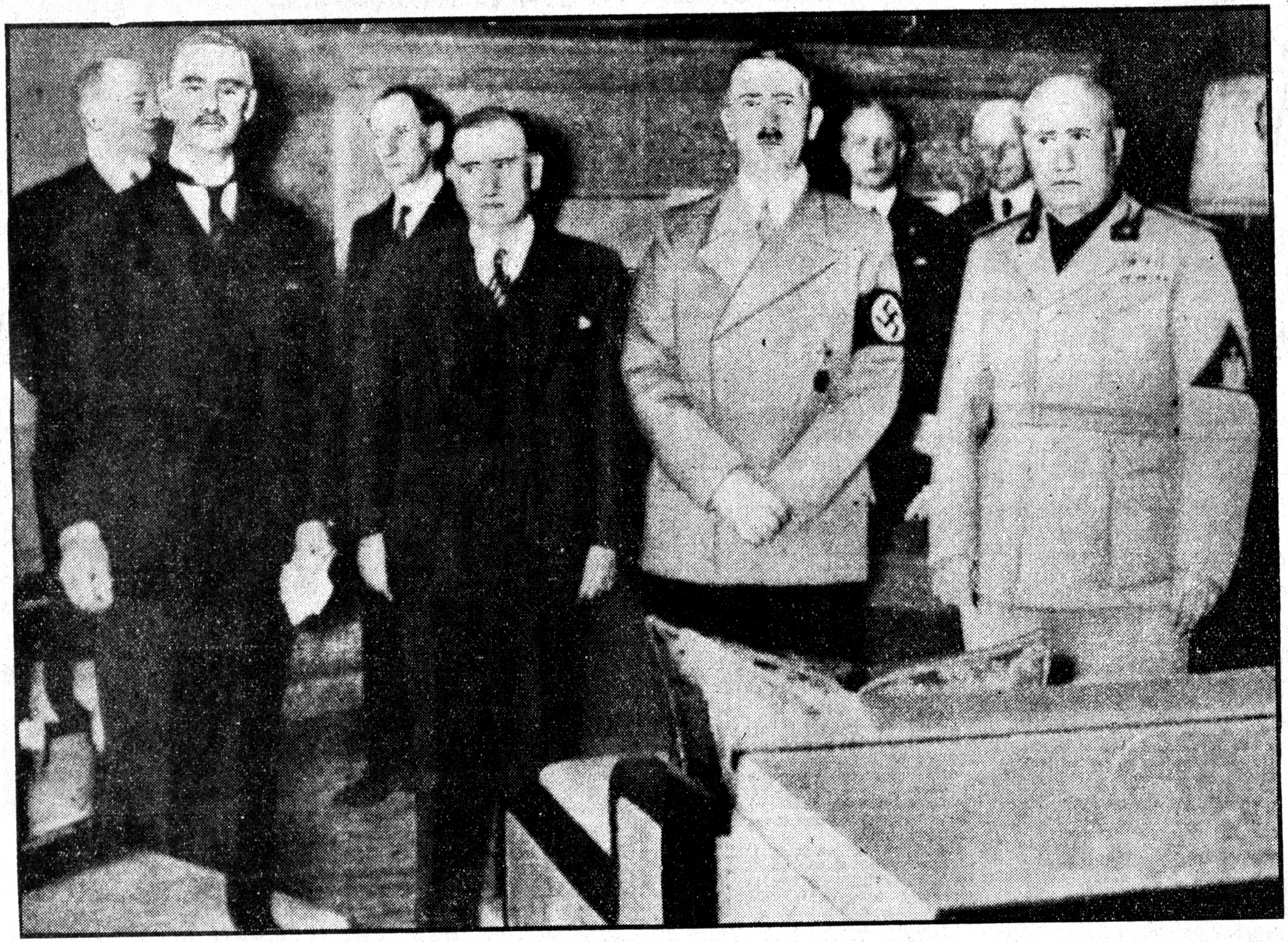
The "Big Four" get together



AT THE FUHRERHAUS, Munich, yesterday: Mr Neville Chamberlain, M Daladier (France's Premier), Herr ...

CZECHS MAKE MORE

To Britain's defence, £40,000,000 this wee...

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Daily Express Staff Re...

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To Britain's defence, £40,000,000 this week

AT THE FUHRERHAUS, Munich, yesterday: Mr Neville Chamberlain, M Daladier (France's Premier), Herr Hitler, and Signor Mussolini.

A.R.P. COST IS MORE THAN THE NAVY

Daily Express Staff Reporter

PAUSE a minute to count the cost of Britain's national defensive measures of the last week.

The bill when it comes to be paid will be huge. At a rough calculation a cheque for £40,000,000 will barely meet it.

Where has the money gone?

The figures I give are only general estimates. They are based on the knowledge of experts and known figures budgeted for in advance of the day when war might come.

To mobilise and maintain the Navy on a wartime footing will mean probably a bill of £10,000,000.

This year the A.R.P. Department were scheduled to spend £8,000,000. Local authorities were to have laid out probably another £5,000,000.

Gas masks alone have absorbed £6,000,000. They cost the Government half-a-crown each.

The A.R.P. Department's Bill for sand will total £2,750,000.

The rest has gone in fire-fighting appliances, labour for trench digging, reinforcing buildings, other raw materials.

£1 A WORKER

A business expert estimated for me the approximate cost to the commercial world to make their premises and staffs safe.

He put the figure at £10,000,000. He said that the precautions worked out at about £1 per worker.

There is, too, the cost of calling up the Auxiliary Air Force, manning the anti-aircraft units, organising the women territorials. Put it at £3,000,000. It may be more.

Lastly, the cost to individuals—transport, A.R.P. measures for the home, equipment: Half a crown a head—£5,000,000 for the population, leaving out the young children—is probably a conservative average.

A £40,000,000 bill in a week to defend ourselves may sound a great sum. But think of this:—

The Allied Powers' war bill for 1914-18 was £26,000,000,000.

Had to leave his job

Commander J. M. Bell had hurriedly to leave Brighton tennis tournament, where he is secretary, for service in the Navy.

AKE MORE NCESSIONS

ied in Czech circles in London last night that h Government have agreed to make further

ié stated that the epared to cede to ritory counting 0 per cent. of tants, and asked frontiers of such the new Czecho- pable of existence

Gold leaves France

Gold to the value of £2,300,000 was sent from Paris to London last night. The bullion, weighing about 10 tons, arrived at Folkestone by cross-Channel steamer, and was sent to London in vans attached to the boat express.

"Save petrol"

The Government appealed to all car owners last night to save petrol.

Petrol companies have undertaken that prices will be unchanged for the next 14 days, but it may be necessary to make variations in the marketed grades. If this is done prices will be adjusted accordingly.

It is officially stated that there are "very substantial" stocks of petrol in the country for all purposes.

WIVES HELP TO DIG ARP SHELTERS

Daily Express Staff Reporter

THE north's A.R.P. workers, having in mind the message of thanks from Home Secretary Sir Samuel Hoare and his appeal to continue their good work, made further rapid progress yesterday with no signs of panic.

Work was found yesterday for several thousand additional volunteers in northern counties. Girls assembled gasmasks, motorists carried supplies to distribution centres, unemployed dug raid shelters, and wardens surveyed thousands of cellars in houses and business premises.

The A.R.P. have almost completed one section of the scheme. After Sunday only a small proportion of the population will be without respirators.

Next tasks scheduled for early completion are trenches and shelters under suitable buildings. The work can be carried out at an intensified pace because the flow of volunteers is not diminishing.

Britain has found plenty of people with sound ideas for A.R.P.

Room for 5,000

LEEDS Corporation Engineers' Department yesterday found a disused water main well below the surface. It runs for 2,000 yards from the centre of the city under congested districts. Engineers who surveyed it estimate that 5,000 people could be accommodated in the tunnel.

About 3,000 suburban householders have started digging their own trenches. Many wives did the digging while husbands were at work.

More than half a million gasmasks have been distributed in **MANCHESTER** this week. One factory assembled 7,000 respirators in an hour. More than 2,000 volunteers enrolled for street warden duty in the first four days of this week.

Four first-aid stations in Manchester suburbs are staffed. There will be 12 more next week.

Hospital plan

SALFORD A.R.P. department have arranged to remove hospital patients by motor-bus and ambulance. Plans allow about 1,000 hospital cases to be removed at a few hours' notice.

STRETFORD Corporation workmen are digging trenches in the parks. Further supplies of respirators are expected at the weekend, and plans have been made for quick distribution.

BOLTON has almost completed distributing its 170,000 gas-masks. The A.R.P. committee have plans to provide trenches or shelters not more than 300 yards from the most distant house.

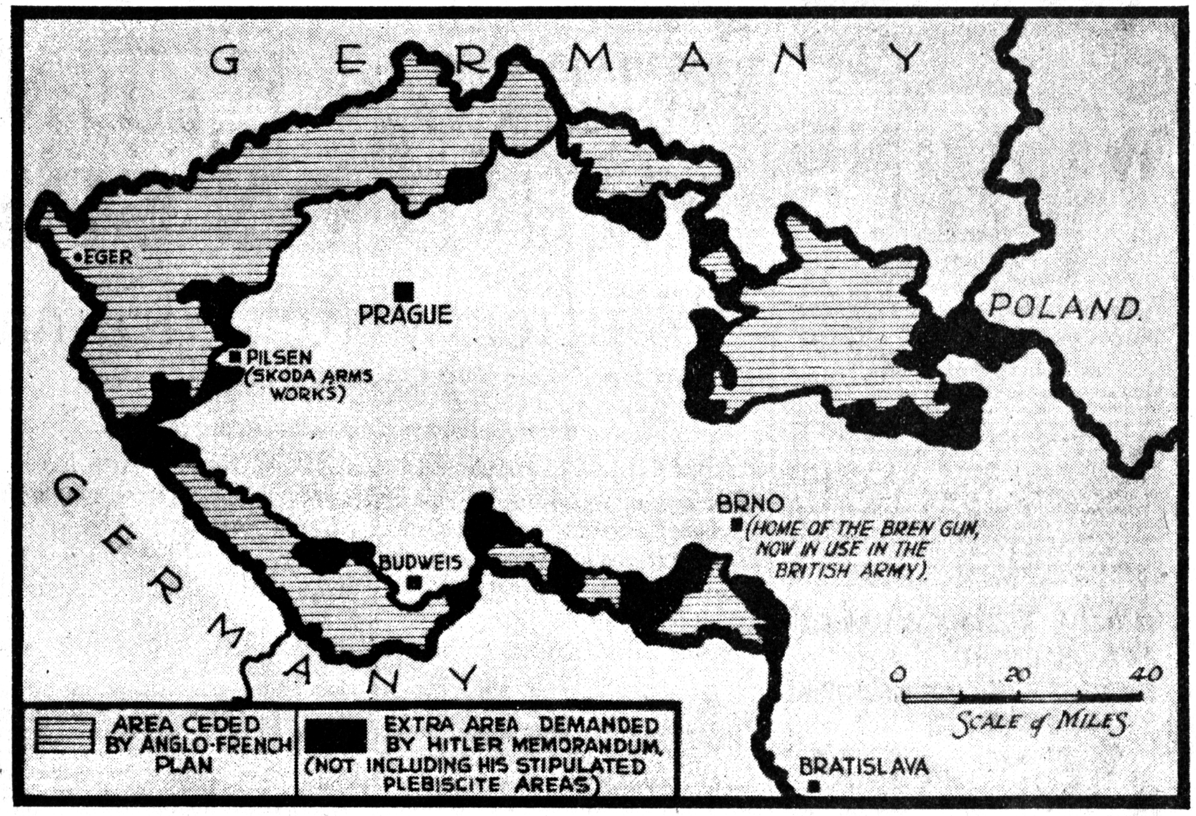
Syren test

Warning syrens at **PRESTON** Dock, the power station, and at points south of the River Ribble are to be tried out at 2 p.m. today.

Distribution of gas masks is rapid and all hospital arrangements have been made.

Rural districts are getting supplies of respirators as rapidly as the towns. Two-thirds of the population in **CHESHIRE** have been fitted. In districts where there are delays temporary shortage of medium and small size respirators is the cause.

Here is the Czech issue at a glance



WHILE THE MEN DID THE TALKING IN MUNICH

From MARY WELSH, *Daily Express Staff Reporter*

MUNICH, Thursday.

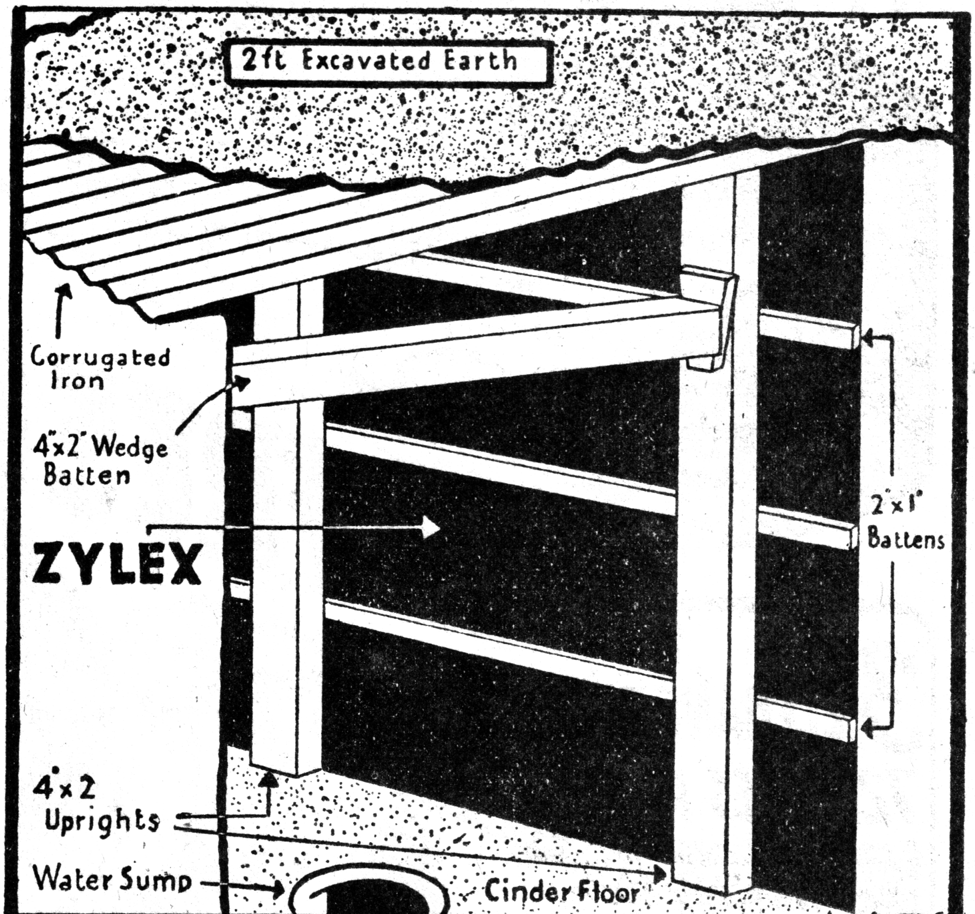
Air records go

All traffic records have been broken at Croydon Airport in the last four days. Hundreds of people left for Switzerland and Germany. Extra liners have been put on the Swiss and Imperial Airways joint service to Switzerland.

Brokers enlist

Two hours after notices were posted at Lloyd's yesterday asking for volunteers for a new anti-aircraft battery, underwriters, brokers, and clerks had hurried to join, and the 150 volunteers required had been obtained. This is the second Lloyd's battery, and a third may be formed.

page 6: bottom right advert



LINE YOUR A.R.P. SHELTER with REINFORCED ZYLEX

$7\frac{3}{4}$d. per yard, **15/6** per roll of 24 yds., 36 ins. wide

CHEAP • WATERPROOF • UNTEARABLE

Saves costly timber. Ensures dry comfort.

FROM ALL BUILDERS' MERCHANTS.

The RUBEROID CO., LTD., 296/302, **High Holborn, London, W.C.1.** *Tel.:* **Hol. 9501 (5 lines).**

Branches:

Birmingham: $66\frac{1}{2}$, Corporation St.
Manchester: 708, Chester Road, Stretford
Newcastle-on-Tyne: Station Rd., Walker.
Edinburgh: Caroline Park, West Shore Road, Granton.
Dublin: 1, Aston Place.
Belfast: 57/59, Great Patrick Street.

AS you read this message from Daily Express Staff Reporter Sidney Smith you take up position on the French side of the Franco-German frontier in Alsace-Lorraine, get a close view of troop activity—and inactivity—of soldiers sitting ten yards apart, some facing east, some facing west, waiting.

BUTTON-EYE CAMERA FOUND ON SPY

Frontier watch drama

By SIDNEY SMITH,
Daily Express Staff Reporter

FORBACH (Franco-German frontier), Thursday.

THE British flag hangs with two French flags over the door of the Forbach frontier post at Breme d'Or, 300 yards away from points where German troops have begun digging new frontier line trenches at Sarrebruck Woods.

It has been hanging there since the British Premier went to Germany.

At the French frontier post, where no more than four cars pass to or from Germany each day, at present all is quiet and otherwise normal.

The French officials sit and watch German troops, all fully armed, occupying the German post 50 yards away, with three times its normal number of officials.

Every half an hour an S.S. motor-cycle dispatch rider races by into Sarrebruck, apparently with reports on French frontier activity.

Every hour German mounted patrols gallop along the international frontier paths. The woods and fields on the German side are being patrolled, especially at night, by armed guards with police dogs.

Chicken for dinner

From the French frontier post a plainclothes policeman, with his regulation field glasses, took me for a walk along the frontier line, over wooded hills and across fields, in which, on both sides of the frontier, German and French peasants were hurriedly gathering in all their vegetable crops.

As we passed up the line behind German Customs buildings, my guide told me: "Don't worry, but you have already been photographed. Every one who goes within view of them on this side is photographed from a room in the German Customs building."

On a side of a thick wooded hill, where only a hedge divides the frontier, my police officer friend asked me to look through a gap. Ten yards away, half-hidden in the hedge, a German soldier sat immobile facing the west. Ten yards beyond him sat another soldier facing the east.

So they are placed at 10-yard intervals, sometimes for hundreds of yards along the edge of the frontier. At another point I saw a shelter of brushwood and tree branches. "That was only built last night," the French police officer told me. "We believe it is a field radio post. Here, take a look through these glasses at that German in uniform down there on the Sarrebruck road."

No speaking

I did. The German was doing exactly the same. We were looking each other in the eye at a mile distant through field glasses. Once we passed within a few feet of a German customs patrol. The two German officers passed without a word.

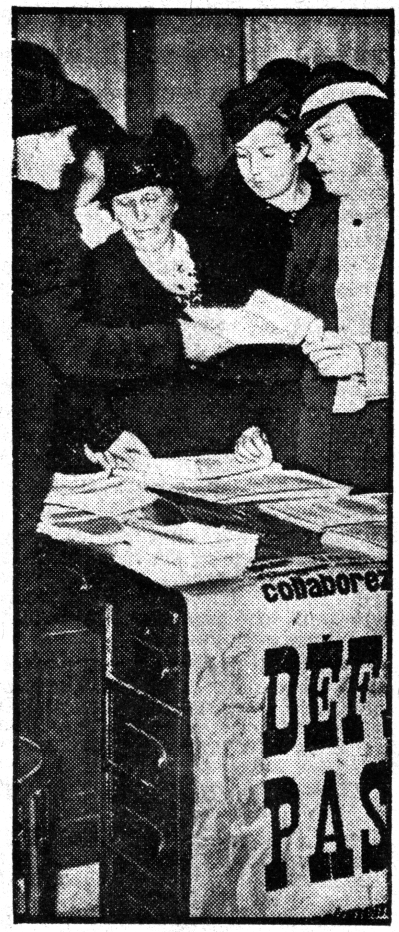
"They never speak to us, hardly ever glance at us. They are not allowed to fraternise," the French officer explained.

The frontier line is the Maginot Line, which lies some miles back, under the tree-covered hills. But in Forbach tremendous counter-espionage activity is taking place. An average of one German agent a day is being arrested.

Yesterday a youth of 19 was arrested. He had in his possession a miniature camera of German make which fitted behind a large imitation button on his overcoat. He had taken photographs of all mobilisation, A.R.P., and other notices put up in front of the Forbach Town Hall.

He had been paid 800 francs, nearly £5, for that assignment.

Today there is a new feeling of optimism all along the frontier as news is awaited from the Four-Power meeting at Munich. But the military and civil upheaval is not yet being retarded for a moment.



Women in Paris offer their services for A.R.P. work. There has been no slackening in the preparations to strengthen the capital's defences against air attack.

TRAGEDIES FOLLOW DAYS OF TENSION

AFTER listening to Hitler's speech in German on Monday night, William Neatham Rumbell, 27-year-old sales clerk,

LINERS AWAIT 'CARRY O ORDER

Daily Express Staff Repor

GERMAN ships all over world, recalled to their h ports on Wednesday, expecting throughout yeste the order to "carry on."

Those due to sail and detain port, which include the liner I burg, and those which have al returned to port, including Atlantic liner Europa, which into Bremerhaven following recall order, were standing throughout yesterday with full s up and all passengers aboard.

The German liner Lichte from Bremen, which put to sea just as she was entering Port harbour on Wednesday and "for an unknown destina returned to Port Said yesterday

It is believed that she is to ceed on her journey east.

CANCELLED

The Cunard-White Star Com have announced the cancellati the sailing of the Aquitania Southampton to New York October 5.

The cancellation, I was info yesterday, has nothing to do the international situation.

At the London offices of the pany, no reason for the cancell was given beyond that it was d "circumstances beyond our con

The cancellation, however definite, and would not be aff by a settlement of the Cz German crisis.

The United States announced that the liner Wash ton would sail from Southam at noon tomorrow instead of Oc 7, as originally scheduled.

This alteration was made be the ship, bound for Hamburg Le Havre and Southam finished her journey at South ton.

A Reuter message from Ca kale, a small Turkish port on south shore of the Dardan stated that three Italian fi trawlers returning to Italy instructed yesterday to wai Canakkale pending developmen

P.M.G. appeals to cut phone ca

The Postmaster-General, than the public for the imme response to his appeal to cut phone talks, says that requiren of the defence services are ma enormous demands upon teleph

He says it has been necessa reserve many trunk lines entire

CAPITALS REJOICE AT PEACE NEWS

Dancing in the streets

Daily Express Correspondent

BRUSSELS, Thursday.

DEMONSTRATIONS of joy took place tonight in the streets of Brussels when special editions of the newspapers announced that an agreement had been reached at Munich.

Thousands of excited people danced in the streets, women wept, while men shouted themselves hoarse.

Britain is highly praised. Many people here have suggested that if any one is deserving of the Nobel Peace Prize Mr Chamberlain is.

Political circles in Brussels are convinced that new conversations will follow the Munich Conference for a possible settlement of all European quarrels.

It is also thought that soon an agreement will be negotiated for a general disarmament.

It is stated here that M Van Zeeland, former Belgian Premier, will be called in to put into application the economic report he has drawn up for Britain and France, and which, I understand, was practically approved by Mr Roosevelt and by Berlin and Rome.

This report contained several practical recommendations for the economic reconstruction of the world.

U.S. JOY

NEW YORK, Thursday.—Headlines announcing the historical Four-Power Agreement met banker and bricklayer, rich man and poor man returning home from work after a week's anxiety this evening.

There were no demonstrations, but it was clear that the whole nation sighed with relief, and that two men are credited with staving off world disaster—Chamberlain and Roosevelt.

ITALY HAPPY

ROME, Thursday.—Newspapers tonight issued one extra edition after another with the latest news from Munich.

Enormous crowds gathered to snatch editions as they arrived. Rome's bars and cafes were filled with people celebrating the passing of the threat of war.

Signor Gayda says in the Giornale d'Italia: "Mussolini's figure now towers in the world's history as the saviour of peace."—British United Press.

ALTITUDE RECORD BID

Pope appeals for peace prayers

THE Pope broadcast this world appeal for peace prayers last night from his villa at Castel Gandolfo, on the shores of Lake Albano:

"While millions of men still live in dread because of the imminent danger of war, and because of the threat of unexampled slaughter and ruin, we gather into our fraternal heart the trepidation of our children. We invite bishops, clergy, religious and faithful to unite themselves with us in the most undaunted and insistent prayer for the preservation of justice, charity, and peace.

"To this unarmed but invisible power of prayer let the people have recourse once again that God, in whose hand rests the destiny of the world, may sustain, especially at this moment, in those who govern, confidence in the pacific ways of patient negotiating and lasting agreement, and that He may inspire in all sentiments and actions corresponding to their respected words of peace, which shall be suited to foster peace and establish it upon a secure basis of law and of the Gospel teachings.

"Grateful beyond words for the prayers which have been and are being poured out for us by the faithful of the whole Catholic world, with all our hearts we offer for the salvation and peace of the world this life which, in virtue of those prayers, the Lord has spared and even renewed."

Bomber's crash kills three

Daily Express Staff Reporter

THREE R.A.F. men were killed yesterday when a bomber crashed and burst into flames in a ploughed field on a hillside at Kedington, near Haverhill, Suffolk.

Farm workers saw the airplane come out of a low bank of cloud

Peace for Spain talk in London

Daily Express Staff Reporter

GENEVA, Thursday.

SENOR PABLODE AZCARATE, Spanish Ambassador in London, had an important conversation tonight with Mr R. Butler, British Under-Secretary for Foreign Affairs, concerning peace possibilities for Spain.

The talk followed the adoption by the League's political committee of a proposal that the League should send a commission to Spain to verify the withdrawal of foreign combatants. Señor Negrin, Spanish Premier, recently decided to withdraw all volunteers from Government Spain.

I understand that Mr Butler and Señor Azcarate discussed what measures the London Non-Intervention Committee might take to bring about withdrawal of foreigners in General Franco's Army.

In Geneva political circles it is thought that as a result of the Munich Conference Mussolini may agree to call out the Italians.

Wasp stung driver, caused his crash

George Taylor, of Latchford, Warrington, Lancs, saved his life yesterday by jumping over the bar from his seat in a public house when a Warrington Corporation bus crashed into the wall and window of the inn.

The crash was caused by the bus driver, Ralph Hewitt, of Walton, Warrington, being stung above the eye by a wasp. No one was hurt.

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Daily Express, 30 September 1938 Editorial:

Daily Express

TELEPHONES.—Manchester: Central 2112. London: Central 8000. Liverpool: Royal 82. Newcastle: 27021. Sheffield: 20418. Leeds: 21236 and 25291. Belfast: 24678. Dublin: 44296.

SEPTEMBER 30, 1938.

PEACE

BE glad in your hearts. Give thanks to your God. The wings of peace settle about us and the peoples of Europe. The prayers of the troubled hearts are answered.

People of Britain, your children are safe. Your husbands and your sons will not march to battle.

A war which would have been the most criminal, the most futile, the most destructive that ever insulted the purposes of the Almighty and the intelligence of men has been averted.

It was the war that nobody wanted. Not the German people. Not the French people. Nobody, above all, in Britain, which had no concern whatever with the issues at stake.

No war for us

Oh, farewell pride, pomp, and circumstance of glorious war.

FAREWELL, a long farewell, we trust. For its pride does not fill our hearts. Its pomp has vanished. And its glory is ashes. Farewell to its gnawing anxieties, its endless blind horror, its fantastic folly.

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We have had enough of those menaces, conjured up from the Continent to confuse us.

From 1914—and on

IN 1914 Germany menaced us on the seas, threatening to interfere with our ocean highways. That was the story.

These

PER

EVERY man I met yesterday has been like a man who was colour blind for a week and could suddenly see again the difference between the blue of a smoke haze, the green of a fir copse. So much they had stared at and not noticed suddenly came alive again. More alive.

First man I met has a home cine-projector and an early Charlie Chaplin film. He spent Wednesday night running it through and through and chuckling at Charlie's subtleties in

b

PA

page 10: full editorial column and full letters section

LETTERS

Opinion

I HAVE read the Daily Express for over 25 years, and would like to congratulate you most heartily on the calm and reasoned manner in which you have presented the news during the present crisis and for the restraint you have shown when commenting on a problem still "sub judice."—**R. H. R. Mitford**, Westbury Road, New Malden, Surrey.

* * *

Peace

PLEASE allow me to thank you for the dignity and optimism with which you have cheered your readers through these dark days.

Your two million odd readers are grateful. Like Mr Chamberlain you have striven after the only thing that matters to humanity—Peace. —**Henry Barratt**, Grosvenor Road, Sale, Cheshire.

* * *

Feet

AFTER seeing St John Cooper's home page cat drawing of a centipede I looked up a reference book to see out of curiosity whether centipedes really have 100 feet.

Most of them haven't. Most of the illustrations showed beasts with 30 feet. The letter press told me that they breathe through little tubes in the side of their bodies, have poison claws, and sometimes kill small slugs by shaking them from side to side as a terrier shakes a rat.

I also learned that there are luminous centipedes, too. Oviedo, companion of Columbus, first noticed them while working on a gold smelting works in San Domingo.—**John Patterson**, Dorset Road, London, S.W.8.

* * *

Worries, but—

I QUITE agree that economic conditions compel many young couples to defer marriage.

Married people with large families have endless worries.

I am, nevertheless, proud to say that I have seven fine, healthy children.—**D. M.**, Carlisle.

Daily Express

TELEPHONES.—Manchester: Central 2112. London: Central 8000. Liverpool: Royal 82. Newcastle: 27021. Sheffield: 20418. Leeds: 21236 and 23291. Belfast: 24678. Dublin: 44296.

SEPTEMBER 30, 1938.

PEACE

BE glad in your hearts. Give thanks to your God. The wings of peace settle about us and the peoples of Europe. The prayers of the troubled hearts are answered.

People of Britain, your children are safe. Your husbands and your sons will not march to battle.

A war which would have been the most criminal, the most futile, the most destructive that ever insulted the purposes of the Almighty and the intelligence of men has been averted.

It was the war that nobody wanted. Not the German people. Not the French people. Nobody, above all, in Britain, which had no concern whatever with the issues at stake.

No war for us

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IN 1914 Germany menaced us on the seas, threatening to interfere with our ocean highways. That was the story.

In 1920 Bolshevism was the menace. It was imperative, so we were told, that we should fight Bolshevism lest it destroy us. We must exterminate that monstrous power.

Such was the cry of those who urged us on to a holy war against the infidels, arguing that we must crush them, root them up, drive them out of their hiding places.

Today's bogey

NOW, in 1938, there is a new menace, some undefined threat in Europe. Against this threat we must take up our arms in defence of our lives and liberties. There is the cry today.

All these frightening pictures are vague in outline. The meanings of these manifestations are hard in truth for the human mind to conceive.

Our biggest menace

BUT one menace is concrete enough. The greatest of all menaces to our society, our stability, the happiness of our people. The menace of unemployment.

It was with us in 1914. It returned, more severe in form, in 1920, and in 1938 it is a real burden upon our shoulders.

Can't we get on with that menace for a time?

Comfort

THERE is one thing about it. Although it is a menace it also represents to us a potential source of strength. The hands that are not working. The muscles that are not in use. The brains that are idle.

The best possible use to which we can put our workless thousands is in preparing our defences.

We can do it. We have the gold. We have the engineering skill. We have the land—countless acres of land which can be brought into fuller production, supplying food for the people.

We have the raw materials, all we need, at home or in the territories of the Empire.

And we have the men.

Get busy

WITH these resources, these vast reserves of power, we can, and we should, make ready to defend ourselves, developing a full and complete structure for the protection of our shores, the defence of our cities, the safeguarding of the seas.

We can weld the men, the money, and the materials into an overwhelming array of weapons, a mighty curtain of defence between the Empire and any who might think of challenging its peace.

When that is done, our Prime Minister can say, like Herr Hitler: "Our fortifications are fully effective for defence."

Daily Express

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A LIGHT!

These foolish thi[ngs]

EVERY man I met yesterday has been

ARP= Air Raid Precautions

Evidence of demand for sandbagged shelters:

A.R.P. DEMANDS FORCE UP SAND PRICES SHARPLY

SUPPLIERS and manufacturers of A.R.P. materials were yesterday given a respite from new orders which may enable them to catch up with the overwhelming demands which have swamped them in the past week.

Builders' merchants, for example, who supply sand, reported that customers who had placed big orders the day before were ringing up yesterday to say that their order had been miscalculated and should only have been for a third of the size.

Even so, such firms as Wiggins and Company (Hammersmith), Thames Grit and Aggregates, and the Eastwoods group have huge order books.

It has been found impossible to meet the demand with "screened" sand, such as is normally used in the building trade. In consequence, sand is being rushed "unscreened" straight from pit to customer.

Some customers are even prepared to accept mould or top soil dressing to fill their sandbags.

Demand has forced up prices sharply. Sand is now selling "unscreened" at about 8/6 a cubic yard, compared with less than a-third of that figure a few weeks ago.

CAUSING BOOM

Shortage of supplies of bags is causing something like a boom for such companies as Jute Industries. Shortage is so acute that emergency sandbags are being made of paper.

Danger of these, however, is that the paper is likely to rot, and the sand may run out and block drains.

London merchants have, therefore, been sending urgent demands to Dundee and elsewhere for fresh supplies.

Urgent demands for supplies of corrugated steel sheets are also reaching manufacturers such as Guest, Keen and Baldwins, John Lysaght, John Summers, and Colvilles.

The corrugated sheet sections of these companies are working near to capacity and special arrangements have now come into force whereby the British Iron and Steel Federation are facilitating deliveries by supplementing the ordinary trade channels.

APPLY DIRECT

Local authorities have been told to apply direct to the federation if they find any difficulty in getting supplies. The federation can then place the orders with the most suitable works.

Prices for sheets are fixed, and consumers are being advised that it is quite unnecessary to pay premiums for quick delivery to merchants or others.

Even with these arrangements, however, a shortage appears to have developed in some parts of London. The sheets are needed not only for air-raid shelters but also for covering glass skylights on roofs where sandbags are being placed.

In the rush to complete preparations boards were substituted for the sheets. The Munich respite, however, is giving supplier and consumer time to make good deficiencies.

Wall Street strong

NEW YORK, Thursday.—The growing prospects for peace in Europe, larger purchases from abroad, and more extensive participation by the public were the chief contributions to a firm upward movement on Wall Street

At the same time it was understood that a considerable volume of potential buying is being held back pending the final verdict of the Four-Power Conference at Munich.

In any case the undertone was strong throughout, and the final list recorded general advances of anything to 3dol. Sales totalled 1,230,000 shares.

The advance broadened out in more active trading towards the end following a report that the Four Power Conference had agreed on essential points, and the close was strong.—Reuter.

Stocks.	Today.	Prev.	Stocks.	Today.	Prev
Call Money ..	Steady	Steady	General Foods	34 5/8	33 1/2
Last business	1%	1%	Gen. Mot New	45 3/4	44
Ex. Ldn. Cbl.	4.78	4.73	Gen. Refract..	31 1/4	29 1/2
Do. 60dy Bills	4.77 15/32	4.72 15/32	Gen. R. Sig...	18 1/8	18
Do. 60dy Com.	4.77 15/32	4.72 15/32	Gillette Raz..	8 1/4	7 3/4
Paris Cables..	2.67 3/4	2.65 1/4	Glidden Co...	21 1/8	20
Berlin Cables	40.06	39.96	Goodrich B.F	22 3/8	21
			Goody'r T.&R	26 3/4	25 1/2
Banks			Houdaille-H..	—	27 3/8
Atlas Trust...	7	6 1/2	Ingers. Rand.	93	91
Cen. Han B&T	79	78 1/2	Int. Harvester	58 1/4	57 1/2
Chase Nat. B.	28 3/4	28 1/4	Do. Nickel..	48 3/8	46 3/4
Manufrs. T...	35	34 1/2	Do. Paper C.	8 3/4	8 1/8
Guaranty T ..	215	213	Do. Ti. & Tg.	8 3/4	8 1/8
National C.B.	22 1/2	22	Johns M'nvile	96	93 1/4
			Kelsey H. 'A'.	10 3/4	9 1/2
Railways			Kennecott Co	42 5/8	40 3/4
Atch. Top....	32 1/2	31	Kroger Groc..	16	15 1/2
Do. Pf.....	48 1/2	46 5/8	Lambert Co..	12 5/8	12 1/4
Balt. & Ohio..	7 1/8	6 3/4	Lehman Corp	25	23
Can. Pac.	5 5/8	5 1/4	Libby-O Glass	50 1/2	49 1/4
Chesap'ke & O	29 7/8	27 1/4	Liggett & M..	90 1/4	90
Chic. M. & S.P	1/2	1/2	Loewes Inc...	49 1/2	47 3/4
Do. R.I.&P..	5/8	5/8	Lorrilard Co..	18 1/2	18 1/4
Del. Lac. & W	5 5/8	5 3/8	Mack Trucks.	23 1/2	22 3/8
Erie..........	2 3/8	2 1/8	Montg. Ward	45 3/4	44
Do. 1st. Pref.	4 3/8	4	Nash Kelv. ..	9	8 1/8
Illinois Cen..	10 1/2	9 7/8	Natl. Biscuit.	23 3/4	22 3/4
Interboro R.T.	4 1/2	4 1/4	Do. Cash Reg	25	23
Lehigh Val...	4 1/4	4	Do. Dairy...	12 3/8	12 1/4
Louis'lle & N.	36 1/2	35	Do. Distillers	23 1/2	22
N.Y. Central.	16 1/4	15 1/2	Do. Lead....	23 3/4	22 3/4
NY Chic & SL	12	10 3/8	Do. Pow.&L.	6 5/8	5 7/8
Do. Ont.&W.	1/2	5/8	Do. Steel....	57 1/4	55 3/4
Norfolk & W.	145	142	N. Amer. Co..	18 3/8	17 5/8
Northern Pac.	10 1/2	10	Otis Steel.....	9 1/2	9 1/8
Pennsylvania	18	16 7/8	Owens Bottle.	69	65 1/2
Reading......	13 7/8	13	Pacific G.& E.	25 3/4	25 3/8
Southern Pac.	15 7/8	15	Packd. Motors	4 5/8	4 3/8
Southern	11 3/4	11	Param't. Pict.	10 1/8	9 1/2
Do. Pref. ..	16 1/2	15 1/2	Patino Mines.	10	9 5/8
Union Pac. ..	85	82	Penney, J. C..	78 1/2	76
Do. Pref. ..	71 1/2	71	People's Gas..	30	28 1/2
			Phelps Dodge	36 1/4	34 7/8
Industrials			Phillips Petm	38	37 1/2
Air Reduction	58	55	Proctor & G..	53 1/2	50 7/8
Allied Chem..	177	173	Pub. Ser. of NJ	28 1/4	27
Allied Stores..	9 7/8	9 1/2	Pullman Co..	29 1/2	28
Allis Chalm's.	48	46	Pure Oil......	10 1/8	9 5/8
Amer. Can....	95	96 1/2	Pur. Bakeries	11 5/8	11
Do. Car. & F.	24 1/8	23	Rad. Cor Am.	6 5/8	6 1/4
Do. Locomo.	18	16 5/8	Remington T.	14 1/4	13 3/4
Do. Metal Co.	32 1/4	31 1/2	Repub Ir.&St.	17 3/8	16 3/8
Do. Pow.&L..	4 1/2	5 1/4	Reynolds Tob	41	40 1/2
Do. Radiator	15 3/8	14 7/8	St. Jos'h. Lead	42 1/4	41
Do. Roll. Mls	17 1/4	16 1/4	Sear Roebuck	68 3/4	66 3/4
Do. Sm.&Ref	44 1/4	43	Shell Union..	14 3/4	14 1/8
Do. Sugar Ref	21 1/4	21 1/4	Simmons Co..	29	27 1/2
Do. Tel&Tel.	160	135 3/4	Soc. Vac. Co..	13 1/4	13
Do. Tob.	80 7/8	78	Standard Bra.	6 7/8	—
Anaconda C..	33 1/4	32 1/8	Stan. Gas & E.	3 1/4	3
Armour & Co.	98 1/8	97 1/4	Stan Oil of Cal	29 7/8	29 1/2
Atlantic Refi.	—	21 1/8	St. Oil of Ind.	28 1/2	27 1/2
Baldwin Loco	8 1/8	7 3/4	St. Oil of N.J.	52 3/8	50 1/4
Bendix Aviat	21 1/8	20	Swift & Co. ..	17 1/2	17 1/8
Bethlehem S..	57 1/8	54 5/8	Texas Sulph..	36 1/2	35 5/8
Boeing Air....	—	21 1/2	Tide Ass. Oil.	12 5/8	12 1/2
Bohn Alumin	25	24	Timken D. Axl	13 3/4	13 1/2
Briggs Manu.	32 1/2	31 5/8	Timken R. B.	46 7/8	44 1/2

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JUNE LANG

FLOTSAM of the crisis, told by Paul Holt: Cinemactress June Lang, whom you remember best as nurse to the Dionne Quins, came to London a few days ago to star in a Twentieth Century Fox film to be made at Elstree, saw a gun emplacement on the Embankment, sandbags at the House, trenches in the park. Decided she didn't like any part of it, caught the Queen Mary home.

Back page

Daily Express
PHOTONEWS
FRIDAY, SEPTEMBER 30, 1938

PEACE MEETING

**Last nig
wired pic**

Daily Express

FRIDAY, SEPTEMBER 30, 1938

PEACE MEETIN

MR CHAMBERLAIN and Signor Mussolini meet for the first time at the Fuhrerhaus, Munich. On one side, looking on, are *(left to right)* Field Marshal Goering, Herr Hitler, Dr Paul Schmidt (interpreter), and Count Ciano, the Duce's Foreign Minister son-in-law. On the other is M François-Poncet, French Ambassador to Germany. Between Mr Chamberlain and the Duce is M Daladier, French Premier. . . After three meetings it was reported that agreement had been reached by the big four on the main essentials of a plan to solve the Czecho-Slovak problem.

CHILDREN from a London nursery school move trainwards at Euston. Thousands of children were evacuated yesterday.

CIVIL DEFENCE

A PRACTICAL MANUAL PRESENTING WITH WORKING DRAWINGS THE METHODS REQUIRED FOR ADEQUATE PROTECTION AGAINST AERIAL ATTACK

BY

C. W. GLOVER

Capt. Late R.A., M.Inst.C.E., M.I.Struct.E., M.Inst.R.A., F.P.W.I.
Lecturer on Civil Defence, Regent Street Polytechnic

EXTRACTS

Note: on page 11, Glover estimates that the "first line strengths" for air power in March 1937 were Germany = 3,500 and British Home Defence = 1,750 aircraft.

LONDON
CHAPMAN & HALL LTD.
11 HENRIETTA STREET, W.C.2
1938

PREFACE

THE ineradicable instinct of self-preservation in man prompts him to clutch at any straw in a vital emergency.

Experience in war has shown that even the resourceful serving soldier all too often exhibits peculiar ideas of what constitutes adequate protection and shelters constructed without the exercise of the fundamental principles of structural stability have proved themselves to be the greater danger.

Yet the mere act of occupying them has contributed in no small measure to the maintenance of mental equilibrium in the stress of many a bombardment.

In the presentation of this volume, attempts have been made to analyse the problems confronting modern society for the adequate protection of the civil population, and it is confidently hoped that its appearance will not be taken as an acceptance of the inevitability of war, but rather as a means of focussing national attention to the moral necessity for the prompt preparation of civil defence.

The author feels it incumbent upon himself to make his position quite clear at the outset.

He has considerable sympathy with the sentiments of the idealist but is forced by consideration of the facts of the present position to abandon utopian ideas and come out in the open definitely a realist.

He is not an alarmist nor an ultra-pacifist and has endeavoured to present and examine the facts fairly and without political bias in the fervent hope that Civilian Defence in all its aspects will be taken up seriously by the nation. The civilian population trained to protect itself will be largely insured against injury and panic and thus the great cities of this country—at present almost an invitation to the air raider—will not present tactical advantages worth the military effort and risk in securing them.

The appalling increase in the offensive power and suddenness of aerial attack makes even the hasty improvisation of defence

	FIG. NOS.
Messrs. Richard Costain Ltd.	77
Messrs. Kontragas Ltd.	78, 79
Messrs. Conjoint Constructors Ltd.	80
Messrs. Nissen Buildings Ltd.	86, 87

The author also wishes gratefully to acknowledge his indebtedness to officials of the Home Office for much valuable help and criticism in the preparation of the work.

Views expressed are solely those of the author and are in no sense official.

Chapters are addressed to the layman as well as the architect and builder, and it is hoped that the details, working drawings and suggestions herein contained will assist forward the humanitarian work of the protection of the defenceless citizen.

C. W. G.

July 7th, 1938.

Inventor and author Captain C. W. Glover, explaining to Pathe news reel his new plan for London's Air Port Of The Future, 1933

SOURCE: http://www.britishpathe.com/video/the-air-port-of-the-future-aka-airport-of-future

CHAPTER I

PROBABLE FORMS OF AERIAL ATTACK

It is obviously not possible to predict the exact form which aerial attack in the future would take, but there is no doubt that the element of surprise and the demoralising effect of the swift use of overwhelming force would be tactical advantages which would be seized by an enemy.

A study of the statistical summary of raids on the administrative County of London during the Great War indicates the tactics then adopted.[65] (See Table I, p. 9.)

The attempts to "set fire to London" from the air persistently carried out in the raids during 1915–17 failed, largely because of the low efficiency of the incendiary bombs then used, the bad marksmanship of the bomber and the brilliantly effective fire fighting services employed by the London Fire Brigade. Out of 354 incendiary bombs on London only eight caused fatal casualties and seven other injuries.

The maximum number of incendiary bombs which fell in London during one raid was 258 and these were distributed over a wide area averaging seven bombs per square mile.

There is no reason why a ruthless and untiring enemy zone bombing from a great altitude should not be able to increase this concentration a hundredfold, using incendiary bombs each many times more effective.

The increased use of high explosive bombs brought about a corresponding increase in casualties and material damage—an effect also observed in Paris. Out of 567 explosive bombs on London, 144 caused fatal casualties and 74 other injuries.

The total number of casualties in England from aerial attack during the Great War were 1,414 killed and 3,416 wounded; material damage £3,000,000, produced by 643 aircraft, which dropped in all 8,776 bombs weighing about 270 tons in the aggregate. About two-thirds was concentrated upon London.

In Germany the number killed by allied air raids is said to

Piecemeal spasmodic efforts in a task of such dimensions are bound to be ineffective; and the avoidance of promiscuous large-scale national expenditure on protective construction can

TABLE I

STATISTICAL SUMMARY OF RAIDS ON THE ADMINISTRATIVE COUNTY OF LONDON DURING THE GREAT WAR.

Date.	Time.	Weather.	Raiders.	Bombs dropped		Killed.	Injured.	Fires.	Damage.
				Incendiary.	Explosive.				
31/5/15	Night	Fine moon	1 Zep. L.Z.38	87	25	7	32	41	£18,396
17/8/15	,,	Clear	,, L.10	40	20	10	48	21	5,000
7/9/15	,,	Mist	{ Zep. L.Z.74 / Ship SL.2 }	27	18	18	38	8	7,809
8/9/15	,,	Clear	Zep. L.13	45	13	22	87	29	530,787
13/10/15		Clear, slight N. wind	{ Zep. L.13 / ,, L.15 }	39	24	38	87	13	50,250
24/8/16	,,	Rain	Zep. L. 31	8	36	9	40	6	130,000
23/9/16	,,	Misty	{ Zep. L. 31 / ,, L.33 }	46	27	26	73	30	64,662
28/11/16	Day	Sunny	1 aeroplane	—	5	1	1	—	510
13/6/17	,,	,,	14 Gothas	—	92	145	382	5	125,953
7/7/17	,,	,,	21 ,,	—	64	53	182	7	203,821
4/9/17	Night	Cloudy	9 ,,	—	40	14	48	—	31,548
24/9/17	,,	Clear	3 ,,	16	13	14	49	2	24,002
25/9/17	,,	,,	3 ,,	19	7	6	21	1	16,101
29/9/17	,,	,,	4 ,,	—	24	13	86	—	21,873
30/9/17	,,	,,	8 ,,	2	12	3	29	1	7,600
1/10/17	,,	,,	8 ,,	—	28	11	41	1	44,094
19/10/17	,,	Fog	Zep. L.45	—	3	33	49	1	48,205
1/11/17	,,	Drizzle	3 Gothas	17	21	6	5	4	7,443
6/12/17	,,	Just before day-break—clear	6	258	9	3	15	52	92,477
18/12/17	,,	Cloudy	7 ,,	47	42	13	79	13	225,016
28/1/18	,,	Misty	3 Gothas, 1 Giant	—	44	65	159	4	172,677
16/2/18	,,	Cloudy	1 Giant	—	3	12	6	—	18,229
17/2/18	,,	,,	1 ,,	—	19	21	32	2	38,898
7/3/18	,,	E. wind	3 Giants	—	9	22	29	1	30,530
19/5/18	,,	Fog	19 Gothas and Giants.	—	46	39	128	3	130,733
			25 Raids .	651	644	614	1,746	245	£2,046,614

Table IX

Protection against Perforation and Explosion

Weight of Bomb	Concrete, 5,690 lbs. at 28 days specially reinforced.	Limestone rock or reinforced Concrete (3,130 lb. grade).	Concrete, not reinforced (2,150 lb. per sq. in. at 28 days)	Constructions in Tunnel.		
				Soft Rock.	Compressed Gravel.	Earthy Sand.
50	2′ 4″	4′ 3″	4′ 7″	11′ 6″	18′ 1″	21′ 4″
100	3′ 7″	5′ 7″	6′ 11″	16′ 5″	24′ 7″	29′ 7″
300	4′ 7″	6′ 11″	9′ 2″	24′ 7″	36′ 1″	42′ 8″

It has been estimated that the blast from a 500 lb. H.E. bomb causes an instantaneous increase in atmospheric pressure equivalent to about 200 times that produced by normal wind pressure, say 6,000 lb. per sq. ft. 50 ft. from the burst.

This, however, lasts for but three ten-thousandths of a second and the reaction immediately following results in a pull in the opposite direction. Windows in buildings are often blown outwards due to this effect by the bursting of a bomb in the street.

The whole time taken for blast pressure to act and die away is approximately $\frac{1}{1000}$th of a second, and if the pressure were maintained there are but a few walls in existence that could safely withstand them.

Investigations tend to show, however, that buildings of normal strong construction will not be seriously affected by the blast of 500 lb. high explosive bombs bursting 50 ft. or more away (see Chapters on Shelters).

According to an official Swiss formula the blast pressure at any distance from a high explosive bomb explosion can be calculated as below :

$$P = \frac{248Q}{R^2} \text{ lb. per sq. in.}$$

where Q is the weight of explosive in lb. and R is the distance from the explosion in feet.

In light doors, windows and partitions the stabilising effect of the inertia to resist this instantaneous pressure must be neglected, but in heavy massive construction this effect is appreciable.

CHAPTER III

GAS BOMBS AND THEIR EFFECTS

"GAS" to the layman holds unknown terrors, but thanks to the advance of science it is no longer the most deadly weapon in the hands of a potential enemy.

The total number of compounds known to chemical science is estimated at nearly half a million, and about a quarter of a million have been carefully studied and their various effects recorded.

Nearly all chemical substances exert some toxic influences, but during the World War about 300,000 substances were investigated with a view to their use in combat.

Of about thirty found suitable for use only twelve were finally adopted, the elimination being due to the stringent technical and tactical requirements imposed.

Only about six compounds were notably successful, and the following extract from statistical summaries is of interest.

125,000 tons of battle gases were used by the seven principal countries engaged in the World War (all theatres), the approximate allocation being as below :—

TABLE XI

	Tons.	Lbs. of gas per casualty
Lung injurants . .	100,500	230
Vesicants . . .	12,000	60
Sternutators . .	6,500	650
Lacrimators . .	6,000	0
Total . .	125,000	192 av.

The total gas casualties were 1,296,853, or one for each 192 lb. of gas.

TABLE XII

Quantity.	Form of Agent.	Casualties.	Rate per Casualty.
5,000,000,000 lb.	High explosive	10,000,000	500 lb.
1,389,000,000 rounds.	Non-gas	13,356,435	104 rounds
50,000,000,000 rounds.	Small arms ammunition	10,000,000	5,000 rounds
1,200 tons 9,000,000 rounds.	Mustard gas shell	400,000	60 lb. 22·5 rounds

Mustard-gas shell proved to be twice as effective as the average gas shell and nearly five times as effective as explosive shells.

The mobilised forces engaged in the World War aggregated 68,321,638, 54·7 per cent. of which became casualties. Although gas caused 4·6 per cent. of all battle injuries and 5·7 per cent. of all non-fatal battle injuries, it caused only 1·32 per cent. of all battle deaths.

Gas was therefore over four times as effective in causing non-fatal casualties as in causing battle deaths.

Modern warfare does not take the form of annihilation of the forces in the field so much as the paralysis of the economic resistance of the nations engaged.

Chemical warfare being most effective in producing non-fatal casualties, which are a military liability, is likely therefore to be adopted to an increased extent in future wars. Indeed it is now clear from the plans of the belligerents in the World War that had this continued for another year the campaign in 1919 would have been largely a chemical war.[74]

Among the gassed the sufferings are less severe and of shorter duration than those caused by other battle injuries, and statistics show that on the whole recovery from gas incapacitation occupied about half the duration of hospital treatment required in other cases of wounding.

The ratio of deaths to total casualties in non-gas cases was over twelve times that of the mortality from gas.

Gas warfare is therefore most effective and humane, and must be expected to play an important part in future wars.

It is a common misconception that there are some gases suitable for use in chemical warfare and which are incapable of neutralisation or filtration by any known means.

" Those well qualified to speak on the subject, notably

Professor Haldane, have adduced a number of scientific reasons for disbelieving in the existence of such gases, and also in the likelihood of their being produced by future research. The explanation is simple. The number of volatile chemical substances is limited, and of these only a small proportion are poisonous. Those with a small molecular weight are on the whole the most volatile, *i.e.*, go most easily into vapour. *But they are all of relatively simple chemical composition, and the larger majority are already known.* Any fears on this ground are therefore practically negligible. With regard to the substances of high molecular weight, it is certainly possible that some may yet be discovered to give off vapours more poisonous than any known gas to-day. But, on the authority of Professor Haldane, *the charcoal in the ordinary respirator has the property of adsorbing heavy molecules of vapour quite independently of their chemical composition.* And what, it may be asked, of gases like carbon monoxide and hydrogen arsenide which attack and kill without causing odour or irritation? Again the explanation is simple. Such gases may prove fatal if encountered in the laboratory or factory; but in the concentrations required to kill by an attacking force they could not practically be produced in the open." [66]

Gas attacks on a civil population can be rendered practically harmless by the equipment and organisation of the community properly to combat them.

The underlying principles of chemical warfare can be traced to ancient times when "Greek Fire," reputed to be compounded of sulphur, spirits of wine, pitch, salt, olive oil and resin, was used in the eighth century B.C.

In 1811 the systematic use of sulphurous fumes and carbon smoke as an offensive weapon was proposed by Lord Cochrane, but it was not until 1915 in the Great War that noxious and toxic gases were effectively employed as a belligerent weapon.

Brief particulars of gases now used in war are tabulated on p. 37:—

There are two main types of poison gas which might be used, namely:—

(1) Persistent. (2) Non-persistent.

Persistent gases usually consist of liquids (*e.g.*, mustard gas)

TABLE XIII

POISONOUS GASES

Substance.	Chemical formula.	Date of introduction.	Boiling-point, degrees centigrade.	Approximate concentration to incapacitate a man in a few seconds owing to lachrymation or coughing.	Approximate concentration which if breathed for more than one or two minutes would cause actual damage to the lungs.	Gas concentration which will prove fatal if breathed for half an hour. Milligrams per metre cube.
			LUNG INJURANTS			
Chlorine	Cl_2	1915	− 33·6	1 : 10,000	>1 : 10,000	250
Phosgene	$COCl_2$	1915	+ 8·2	1 : 100,000	1 : 50,000	15
Trichlor-methyl-chloro-formate	$Cl.COO.CCl_3$	1916	+ 128	1 : 200,000	1 : 50,000	17
Chloropicrin	CCl_3NO_2	1916	+ 112	1 : 200,000	1 : 50,000 (Cumulative)	70
			LACHRYMATORS (ACTION ON EYES)			
Xylyl bromide	$CH_3C_6H_4\ CH_2Br$	1915	+ 218	1 : 2,000,000	—	
Ethyl iodo-acetate	$CH_2ICOOC_2H_5$	1916	+ 180	1 : 5,000,000	1 : 50,000	
			PARALYSANTS (ACTION ON NERVOUS SYSTEM)			
Hydrocyanic acid	HCN	1916	+ 26·5	>1 : 2,000 (immediately fatal).	No cumulative action.	15
			(SENSORY IRRITANTS OF EYES, NOSE AND CHEST (STERNUTATORS)			
Diphenyl-chlorarsine	$(C_6H_5)_2\ AsCl$	1917	+ 383 (M.P. 43)	<1 : 10,000,000	1 : 50,000	
Diphenyl-cyarsine.	$(C_6H_5)_2\ AsCN$	1918	>+ 350 (M.P. 31)	<1 : 10,000,000	1 : 50,000	130
Ethyl di-chlorarsine	$C_2H_5AsCl_2$	1918	+156	1 : 500,000	1 : 20,000	
			VESICANTS (EVAPORATION IS SLOW AND ACTION IS THEREFORE "PERSISTENT")			
Dichlorethyl-sulphide (Mustard gas)	$(CH_2ClCH_2)_2S$	1917	+ 217 (M.P.+14)	—	1 : 100,000 (with 60 min. exposure).	50

which contaminate the area on which they are released, and may continue to give off vapour for hours, days, or even weeks, if not neutralised.

Non-persistent gases, when released, rapidly mix with the atmosphere and disperse quickly.

War gases must have an injurious effect in low concentrations, must be heavier than air and capable of a wide distribution.

They may be released on civil populations from gas bombs or by spray from aeroplanes in liquid form, or irritant smokes.

Persistent gases of the mustard type are most dangerous when released as spray, as the drops of condensed "gas" may remain unsuspected on objects which may come into contact with the human body.

FIG. 25.

On December 11th, 1915, the Germans first used the deadly phosgene gas. The British Intelligence Service obtained five months' notice, and also ascertained the sector in which this would be employed. The attack was successfully met by the timely issue of a modified form of P.H. helmet which had two eye-pieces and an outlet valve of rubber. It was impregnated with caustic soda, phenol and glycerine, producing sodium phenolate, which neutralised the phosgene. It was known as the P. helmet.

To meet the increasing concentrations of gas in 1916 the British box respirator was introduced. This had a canister filter carried in the haversack connected with a rubber pipe to a mouthpiece. A nose-clip prevented breathing through the nose and close-fitting goggles inside the face-piece were used to protect the eyes against lacrimators.

With but small improvement this mask served the British till the end of the war.

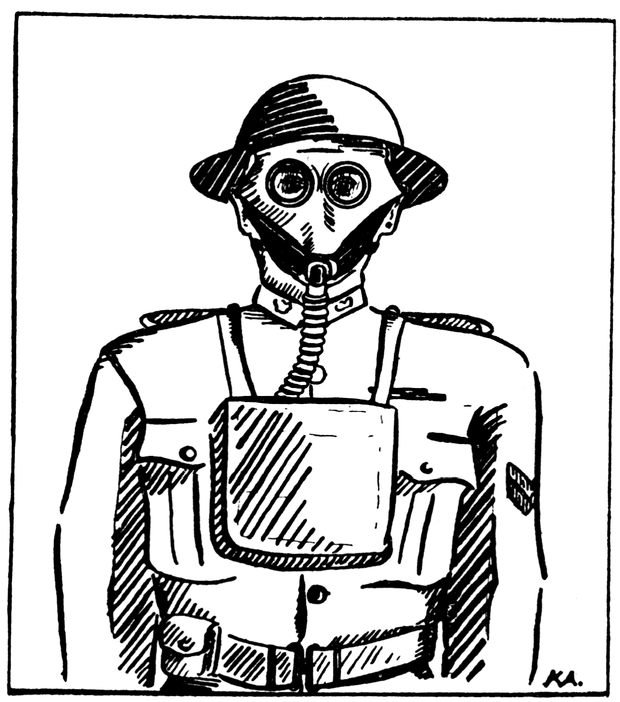


FIG. 25.

FIG. 40.—The general Civilian Respirator, 30 millions of which have been manufactured and stored officially for local issue in an emergency.

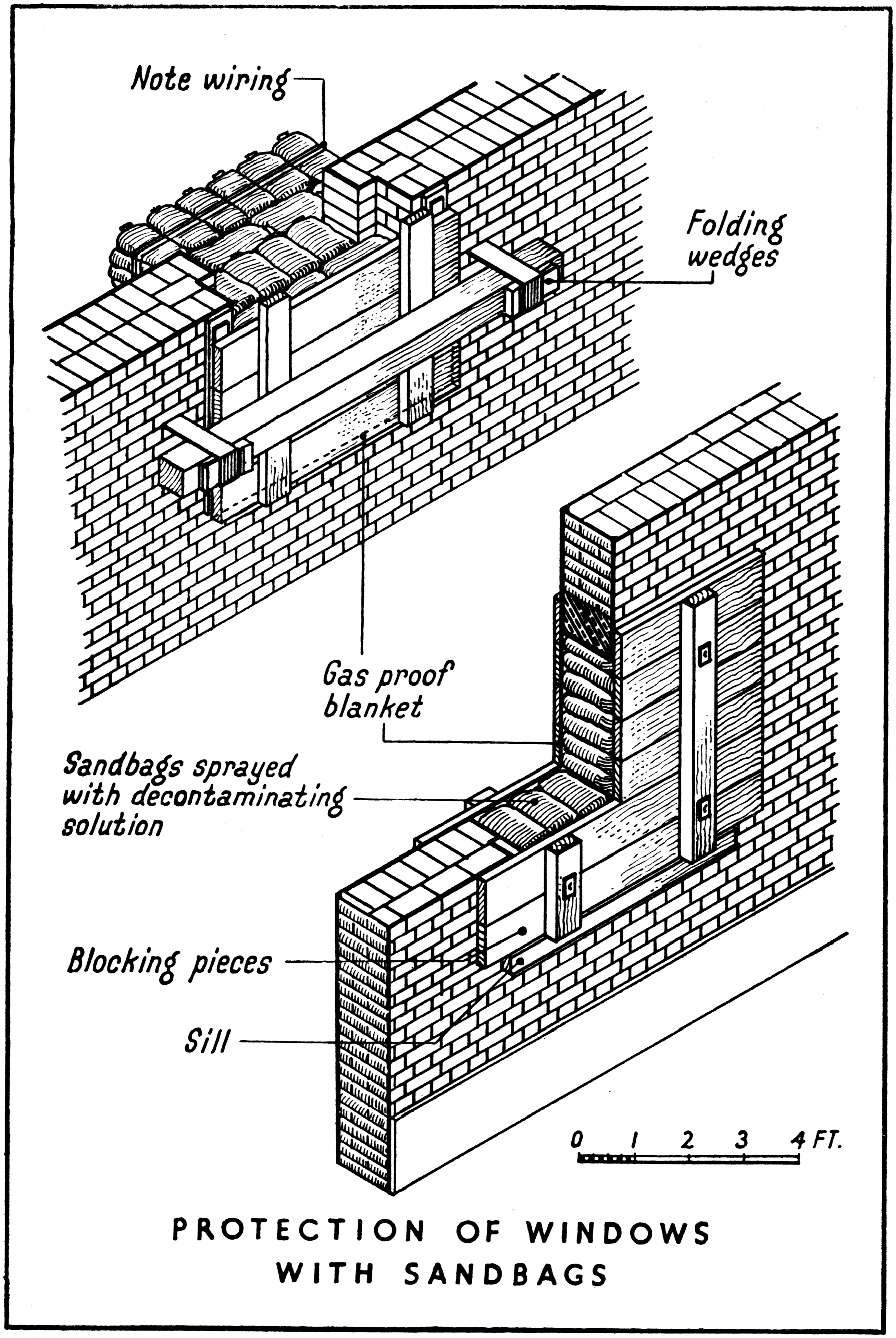


FIG. 46.—Protection of window opening with sand-bags.

Fig. 62.—Norcon tubular shelter (emergency exit not shown).

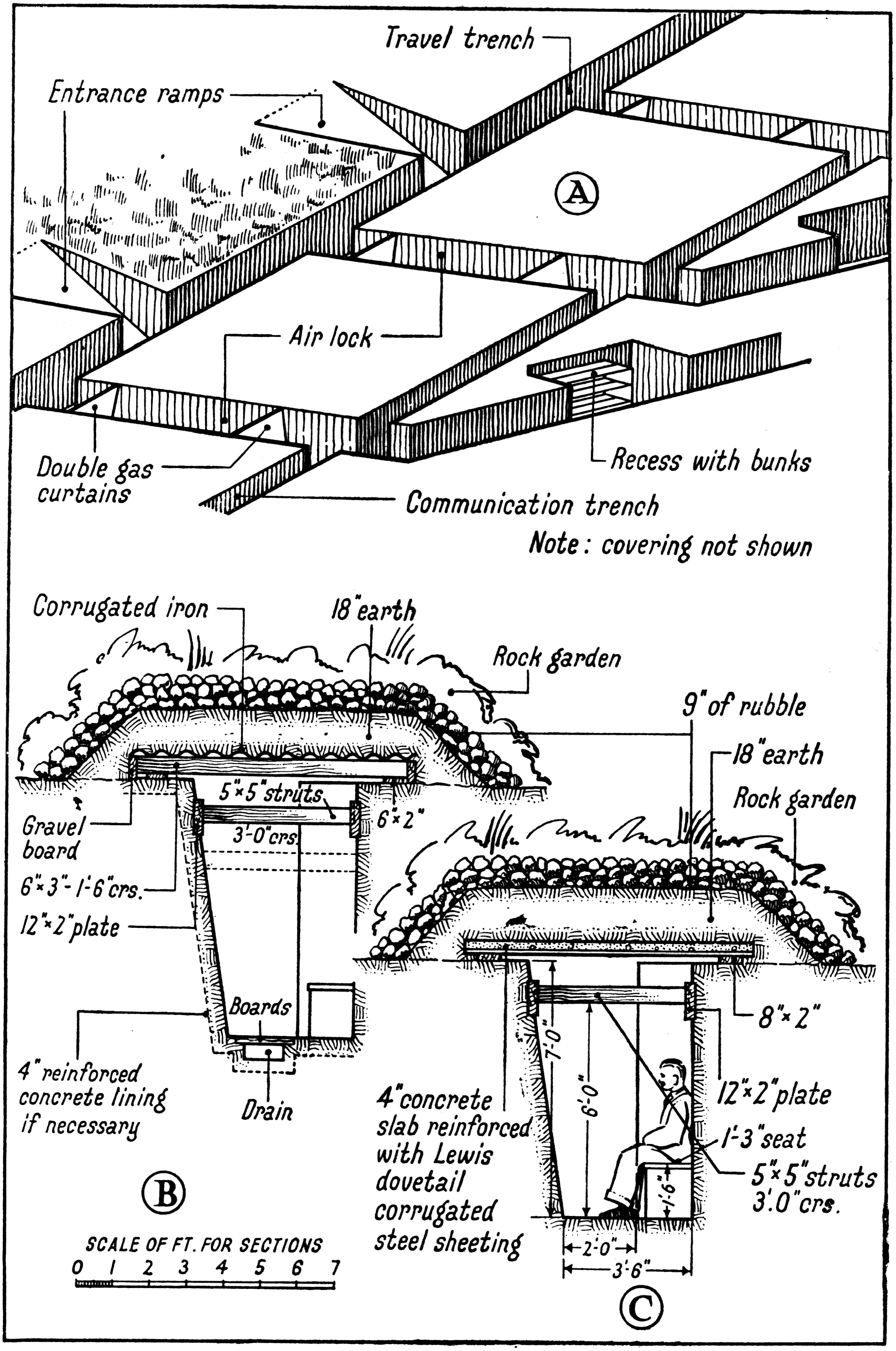


FIG. 72.—Showing (A) entrance to trench system Fig. 71. (B) and (C) alternative sections.

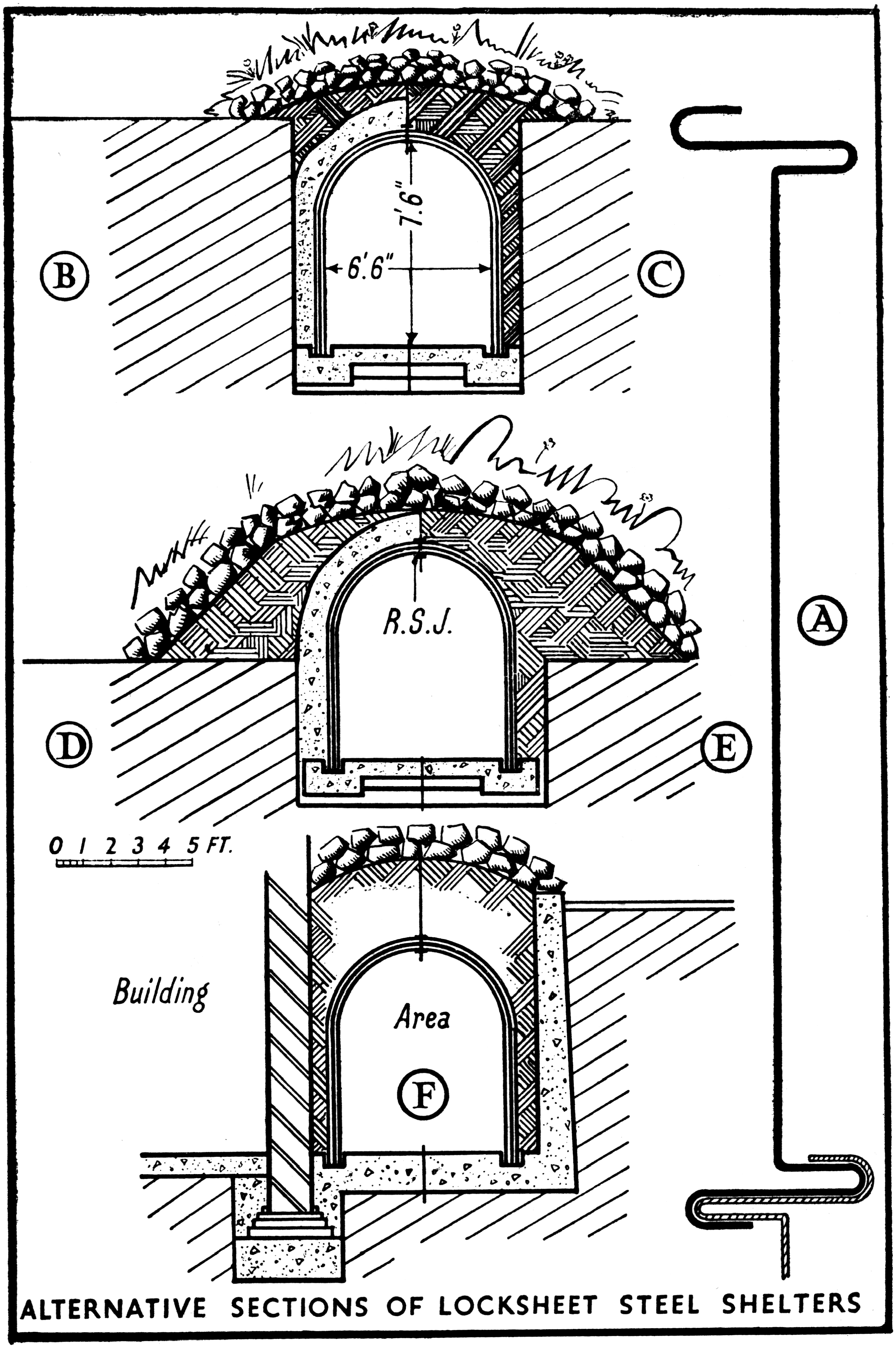


FIG. 77.—Costain's locksheet steel shelters. A, enlarged section of locksheet steel; B, constructed in deep trench and covered with concrete, earth and rubble; C, constructed in deep trench and covered with earth and rubble; D and E, partly underground, and F, in area of building.

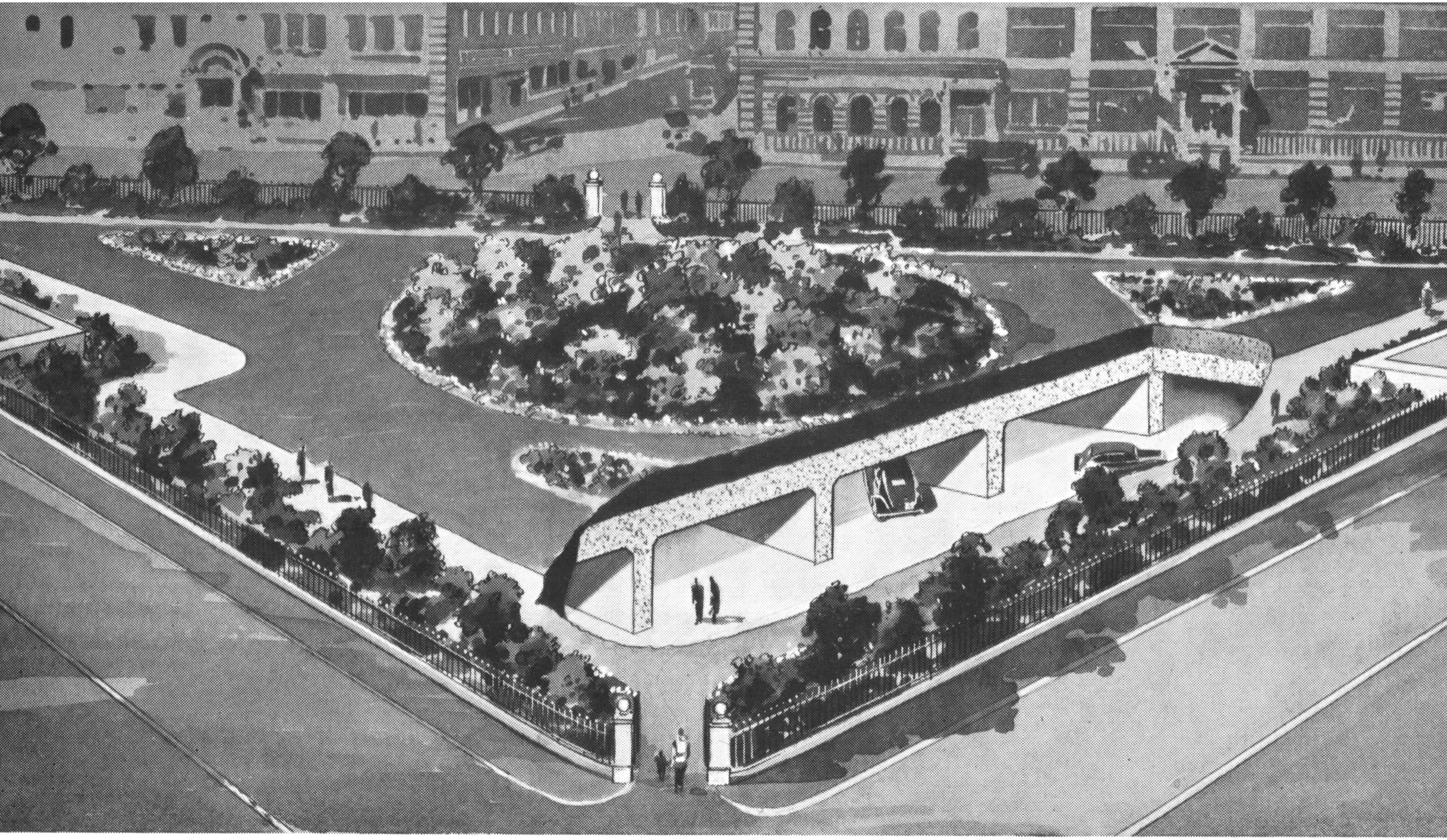


FIG. 88.—Garage under public gardens providing the much needed peace-time accommodation for cars and shelter for the floating population in an air raid.

before and after evacuation. It would therefore appear that allowing for a certain necessary amount of duplication of shelter accommodation, provision should be made ultimately for the following protection :—

TABLE LI

	Population.	Cost per capita.	Total cost.
Principal danger zones requiring shelters proof against *heavy bombs* . . . . . (Allowing for 33⅓ per cent. additional accommodation for use before evacuation.)	4,000,000	£30	£120,000,000
Medium danger zones requring shelters proof against *small bombs*	20,000,000	£10	£200,000,000
Outskirts of towns requiring *splinter-proof protection* . . . (Allowing 14 per cent. additional accommodation.)	8,000,000	£5	£40,000,000
Rural districts requiring *no special protection*	15,000,000	—	—
TOTAL POPULATION FOR WHICH SHELTER ACCOMMODATION IS NEEDED .	32,000,000		£360,000,000

It is probable that a fair percentage of shelters, especially of the light bomb and splinter-proof type, can be provided by the adaptation of existing premises, thus reducing materially the total cost of new work. Against this saving has to be set the costs of transportation, temporary housing and general provisioning of the evacuated population.

On the whole, therefore, a total national expenditure approximating 300 millions sterling will be incurred in the adequate passive defence of the civil population of the British Isles.

That this expenditure shall be as productive as possible it will be necessary to ensure that the highest possible proportion of shelters are constructed for the dual purpose of some peace-time use and the assurance of protection in emergency.

Public money will be expended as well as a great deal of private money, but the very nature of the construction will render shelters less vulnerable than ordinary buildings in air

A peace-time utilisation of an air-raid shelter might therefore render the " addition or improvement " liable to taxation.

EVACUATION

Evacuation necessarily forms an important part of any general scheme for passive defence and the French plans are worthy of consideration.

In 1936 the French Government issued a handbook on evacuation, and the following extracts and notes are of interest.

There is no doubt that the orderly and methodical execution, at the time of need, of a plan of evacuation which has been carefully prepared in every detail during peace time is calculated to save a great number of human lives. Such a result makes it worth while to make every effort to prepare such a plan, in spite of all difficulties that may be encountered. The general scheme proposed by the French handbook recommends :—

" (1) All persons who will leave the town voluntarily should be encouraged to do so.

" (2) Permanent evacuation of the people unimportant from the military or administrative point of view into the country districts.

" (3) Evacuation of people whose relatives must remain in the town, to places nearby.

" (4) Nightly evacuation of people who must work in the town.

" (5) Shelters to be provided for all people who must remain in the town.

" These plans must be formulated by the mayor of the town, and he must arrange with the local authorities of the villages how many refugees each village can accommodate. The order for evacuation will be given by the Government before they issue the order for the mobilisation of the armed forces.

" It is proposed that each person should have an evacuation ticket at the outbreak of a war and these tickets are already printed.

" Such a ticket would read as follows :—

" ' Mr. X. is instructed to take the 8 p.m. train this evening from the Gard du Nord for Amiens. He is to take

with him his wife and four children, travelling in seats Nos. 37–42 inclusive.' "

In this country detailed arrangements are not yet disclosed but Sir Samuel Hoare, in the House of Commons on June 1st, 1938, explained that time-tables had been worked out to move 3,500,000 people by rail fifty miles from London in seventy-two hours, without train tickets. Evacuation is obviously a more effective passive measure than the provision of shelter accommodation but complete evacuation is not possible.

It would probably be safe to assume that all children under the school-leaving age, babies and their mothers, old people and invalids, amounting to about 25 per cent. of the urban population, could be permanently evacuated to areas requiring no special protective measures.

All specially dangerous locations might also be vacated except for a permanent cadre of key men, thus possibly accounting for another 10 per cent. of the population.

The central zones of cities and areas near military objectives would need the highest degree of protection and the outskirts splinter-proof protection.

The difficulties attendant upon evacuation would cause delays in its execution and it would therefore be necessary to provide shelter protection on a crush capacity basis for larger numbers at the outset.

It would consequently appear that the distribution of the urban population would be adjusted in an emergency somewhat on the lines indicated below:—

TABLE LII

APPROXIMATE DAY-TIME DISTRIBUTION OF URBAN POPULATION

	Before evacuation.	After evacuation.
Principal danger zones .	13,000,000	3,000,000
Medium danger zones .	22,000,000	20,000,000
Outskirts of towns . .	10,000,000	7,000,000
Rural districts . .	Nil	15,000,000
Totals . .	45,000,000	45,000,000

HOME OFFICE

CIVIL DEFENCE
TRAINING MEMORANDUM No. 3

The Control of Civil Defence Operations under Fall-out Conditions

(England and Wales)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1959

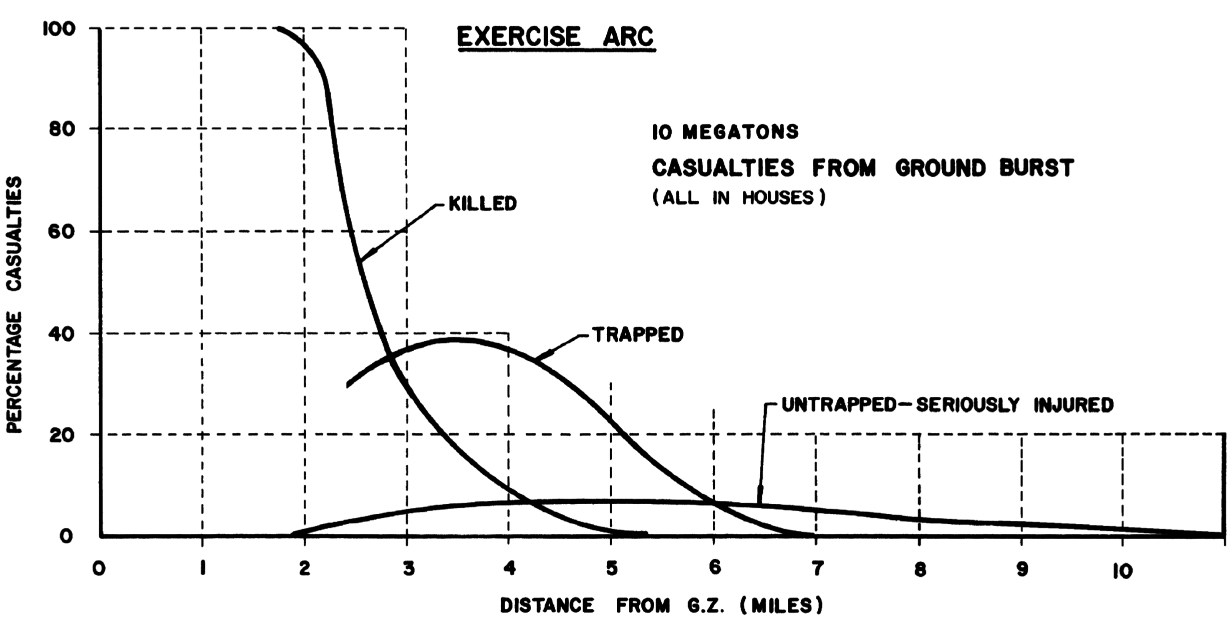
SIXPENCE NET

Civil Defence Training Memorandum No. 3, "The Control of Civil Defence Operations under Fall-out Conditions," U.K. Home Office, 1959

Paragraphs 6-14 explain that the need for rapid life-saving rescue and evacuation from the damaged areas near ground is to be balanced by the fallout gamma dose rate hazard to the civil defence workers; for optimum results first aid and rescue workers should move inwards (toward ground zero) at about the same speed the 10 R/hour gamma outdoor dose rate contour moves inward due to the natural radioactive decay of fallout (because fallout radiation decays rapidly, the dose rate at 48 hours being only about 1% of that at 1 hour):

"The balance of advantage would differ according to the nature of the work; but for the rescue and casualty services it is thought that the best results would be obtained from working at or about a dose rate of 10 R/hour, so that the wartime emergency dose [75 R] was used up in a single shift of about 8 hours. … Some forces, e.g. ambulances, could operate profitably where their dose was spread out over longer periods than 8 hours by working at lower dose rates than 10 R/hour. Others, e.g. reconnaissance parties with special responsibility for rapid penetration, might have to take their wartime emergency dose without heed to the 10 R/hour [fallout map pattern/contour] line and reduce their working period accordingly. … units would continue with their task … with reference only to the total dose accumulated on their dosimeters. … The radiological limit should be taken as the 1,000 R/hour at H + 1 contour which will be 10 R/hour line at H + 48 [due to the 100 fold decay of fallout radiation between 1 and 48 hours after a nuclear explosion] and so mark the limit to which life-saving forces can be expected to have penetrated by that time. …

"The task will be set by the number of casualties trapped, or seriously injured but untrapped … capable of being succoured within the first 48 hours. As soon as possible after ground zero, weight and nature of attack are known, the Controller should have casualty estimates made … This will be done by applying the population figures for the Sectors casualty percentages as shown on the graph (from Exercise ARC) attached as an appendix to this memorandum, which sets out, on the best evidence at present available [blast casualties from applying Blitz casualty data as a function of house damage to nuclear test data showing the amount of house damage versus distance from a nuclear explosion, which automatically takes account of the duration of the blast wave in nuclear explosions], the proportions of seriously injured, trapped and untrapped, to be expected at different distances from ground zeroes of bombs of varying power. … A single Forward Medical Aid Unit can be expected to deal with about 120 seriously injured an hour – say 1,000 in each shift – and to continue working throughout the operational period with only internal reliefs. … At the beginning of operations a 4-berthed ambulance can be expected to take about 1 hour on the round trip from ambulance loading point … A single casualty collecting party can handle and send to ambulance loading points about 12 seriously injured an hour, or, say, 100 per shift [8 hours]. … A single [light] rescue party [using slow manual methods used in 1941, without any of the tracked cranes used and rescue dogs used to rapidly clear debris of casualties in the 1944-1945, during the V1 and V2 attacks on London] can release two or three trapped persons an hour or, say, 20 per shift.



HOME OFFICE
SCOTTISH HOME DEPARTMENT

General Information

(All Sections)

CIVIL DEFENCE
POCKET BOOK NO. 3

LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

Zone	*Dose-rate at H+48 hours*	*Summary of permissible and recommended action*
W	Less than 0.3 r.p.h.	Remain in refuge until released, which can be as soon as dose-rate falls to 0.3 r.p.h. or when fall-out is complete if the rate has not reached that figure.
X	0.3—3 r.p.h.	Remain in refuge until H+48 hours; then qualified release. Indoor workers to follow normal occupations, but not to exceed 4 hours per day in the open for the next 5 days. Outdoor workers would have to do half shifts to keep within this figure. At the end of a week the zone would be normal, except that all would be advised to be out of doors as little as possible, and not in any case to exceed 8 hours per day in the open for the next 3 months.
Y	3—10 r.p.h.	Remain in refuge until at least H+48 hours; then release under stringent control. For the next 12 days time in the oper should not exceed 2 hours per day. On this basis essential indoor workers should be able to get to their work, but outdoor work would remain suspended. After the first fortnight it would be possible to increase the essential time spent out of doors to 4 hours per day for the next three weeks, increasing this to 8 hours per day thereafter for the rest of the first year.
Z	10 r.p.h. or more	Remain in refuge until told to leave. All movement outside refuge in this zone would be dangerous. People should remain until instructions for clearance are given; they should then leave by the nominated route if they have means of transport—or wait in their refuge to be collected if they have not. The clearance operation might start after H+48 hours and removal from the Zone would be for at least 3 months.

HOME OFFICE

CIVIL DEFENCE

TRAINING MEMORANDUM No. 4

The Clearance of Z Zones by Road

(*REVISED* 1965)

(Z Zones are fallout areas where the 48 hour gamma dose rate is above 10 R/hour. This corresponds to a dose rate of 1,000 R/hour or more at 1 hour after a nuclear explosion. The outside dose accumulated from an arrival time of 1 hour after a 1 megaton burst, up to evacuation at 48 hours, is:

$$\text{Dose} = 5 \times 1000 \times (1 - 48^{-0.2}) = 2{,}700 \text{ R outdoors}$$

or 67 R in a brick house's room with blocked windows)

LONDON

HER MAJESTY'S STATIONERY OFFICE

1965

SIXPENCE NET

The Clearance of Z Zones by Road

Introduction

1 This memorandum is concerned with the drill for clearance by road from those parts of a Z Zone which are not in a damaged area. In a damaged area the drill would have to be modified as necessary to meet the special conditions obtaining, e.g. restriction of road access. The memorandum deals only incidentally with the areas to which people will be cleared. It is assumed that 'assembly towns' of, say, from 8,000 to 50,000 population at distances up to about 20 miles from the Z Zone will be selected to receive those cleared; and that the bases from which clearance operations will be mounted will be on the outskirts of those assembly towns commanding main routes into the Z Zone. It may sometimes be desirable to site the clearance bases further forward; in which case staging points will be set up from which people will be transported to the assembly town by train or other means.

2 In clearance the maximum use must be made of all forms of petrol-driven transport, including public transport already within a Z Zone. Families capable of clearing themselves should do so; and wardens should, so far as possible, arrange in advance that spare places are reserved for neighbours. The opportunity should be taken wherever possible to provide for people living in remote areas without their own transport to be collected by private transport on the way out. This will simplify the task of clearance from outside. Instructions to the public will require that houses left completely empty should be marked by the last person to leave by hanging a sheet out of a front window.

3 The proportion of population capable of being moved by transport already in a Z Zone is likely to be substantial but the remainder will have to be cleared by transport sent in from outside.

4 The closest contact will have to be maintained at every level between the warden organisation within the Zone and the clearance forces working from outside. The wardens will be responsible for providing clearance forces with essential information; and, in anticipation of the area coming within a Z Zone, should make the preliminary plans described in Appendix I.

General principles of clearance

5 The physical clearance of a Z Zone would rarely start before H+48 hours although planning might be instituted at an earlier time. The wartime emergency dose of 75r will apply to all engaged. The object will be to clear the Zone as quickly as possible within the limits set by this dose and the size of the forces available.

6 Clearance by night or when visibility is bad, is likely to increase the time of exposure and should be avoided if possible. Delays caused by suspending clearance during the hours of darkness would make little difference to the total dose received by those in their fallout rooms in the Z Zone.

7 For clearance from outside, passenger carrying vehicles with a capacity of not less than 30 should be used. The use of vehicles of lesser capacity would be radiologically extravagant to clearance personnel, and should not be used unless there is no practical alternative.

8 Zones will be cleared inwards sector by sector or district by district. Throughout each sector or county district* council areas in turn self-clearance will be effected first and clearance organised from the outside will then be undertaken as far as possible simultaneously in every warden post and patrol area.

9 Clearance vehicles will operate in convoys of about five. In general one convoy will be allotted to each patrol area. To avoid unnecessary exposure to radiation of their occupants, vehicles should be sent individually to assembly towns as soon as they are loaded unless there is some good reason for acting otherwise. After unloading they will be reformed into convoys at the clearance base.

10 In built-up areas convoys will on their initial trip be directed to the warden posts and from there to the patrol areas they are to clear. In rural areas this method of routing would be radiologically expensive and should be unnecessary. Where the position of a patrol post can be easily indicated on a 1″ map the rule will be for the convoy to go direct to the patrol post in rural areas.

Allotment of responsibilities

11 Overall responsibility for deciding when a Z Zone is to be cleared and where the population of the Zone is to be moved will rest with the Regional Seat of Government which will allot responsibilities to individual Sub-regional headquarters. Responsibility for clearing segments of a Z Zone, and the transport for that purpose will be alloted by Sub-regional headquarters to county or county borough controls. Responsibility for receiving the people cleared will be apportioned to the county or county borough controls within whose boundaries the assembly towns lie. Where responsibilities are separated co-ordination will be maintained by the next higher control, e.g. co-ordination between county or county borough controls by Sub-regional headquarters.

12 A single Z Zone may well extend into two or more Regions and a single Region contain parts of two or more separate Zones. Each Zone will have been given a code name. For clearance purposes segments will be known as Regional, Sub-regional, county, and in some cases county sub, or county borough segments as the case may be, and will be further identified by the appropriate numbers and letters of the responsible control, e.g. county segment (or simply segment) 62A.

---

* NOTE: All later references to 'district' refer to 'county district council areas'.

13 Operations will be conducted by clearance units, set up by the responsible control, which will appoint the commanders, establish the bases and give each unit a segment, to be known as a clearance segment, to deal with. The boundaries of clearance segments should so far as is possible follow those of warden sectors or districts if sectors do not exist. Clearance unit comanders will normally be civil defence assistant controllers (Ops) or mobile controllers, unless the unit is provided by the military or by a police mobile column. Within a county or county borough all units, under whatever command, will be lettered in sequence and the same lettering will be used to identify the clearance segments, e.g. (clearance) segment 62AA.

14 A clearance unit should have about 125 buses or coaches, with an average lifting capacity of, say, 5,000 people. One hundred and fifty vehicles (average lifting capacity 6,000) should be regarded as the maximum. The number of lifts that can be accomplished in a day will depend on the time of year, whether the population of the segment is concentrated or scattered, and the length of run to the assembly town or staging point; but it may be expected to vary from about two to four. County or county borough control must judge from these factors the number of units required and the size of the clearance segments to be allotted to each. During the progress of operations there may well be need to adjust either the boundaries of the segments or the strength of the units.

15 It may be necessary for a clearance unit to call in the ambulance resources of counties or county boroughs in order to clear people whose physical condition makes it impossible to transport them by bus or coach. For radiological reasons the use of ambulances must be kept to an absolute minimum. If there should be an acute hospital, containing a large number of patients, in the Z Zone, special arrangements for their clearance and reception would have to be made at county or county borough level or above.

The clearance unit

16 In order that a clearance unit, when clearing each sector or district in its turn, should be able to work simultaneously in every warden post and patrol area within that sector or district it should have an operational staff approximating to the following "standard".

Clearance unit commander (1): to be responsible for organising the clearance of the sector or district generally.

Clearance officers (5): each responsible for organising the clearance of a warden post area and taking charge of a section of five convoys.

Convoy commanders (25): each in charge of a convoy of five buses or coaches operating in a given patrol area.

Drivers and mates will be needed for the 125 buses and/or coaches and drivers for the six cars with which the unit will be provided. Relief bus drivers should be sought as required, if necessary with the help of local Ministry of Labour representatives.

Signal staff and equipment for maintaining communications with the static control, should telephones not be working, and office staff for a mobile control plus six messengers, would also be required.

17 Of the above, the convoy commanders, bus drivers and mates whose duties will take them constantly in and out of the Z Zone, will have to be replaced as and when their wartime emergency doses are expended—perhaps after seven or eight lifts over two or four days. Clearance officers and car drivers and messengers will also enter the Z Zone, but less frequently and for shorter periods; so that in their case replacement should not be necessary for a long time, if at all.
(For administrative staff at base see paragraph 22).

18 This "standard" unit may be varied as required by increasing or reducing the number of buses or coaches and so the size or number of convoys or convoy sections with consequent alterations in the number of convoy commanders or clearance officers. Considerations of administration and maintenance will, however, require an upper limit of 150 vehicles.

19 Whatever unit is employed there will almost certainly be need to make constant readjustment between the various parts during the course of operations; according, for instance, to the number of warden post and patrol areas within whichever sector is being cleared, their populations, and the particular difficulties they present.

20 The designations used in paragraph 13 are entirely functional. Except where a clearance unit is provided by a military formation or a police mobile column its operational staff may be drawn from a variety of sources. (See Appendix III.) It is of great importance that the right people should be found to act as convoy commanders, since these will have the major responsibility for dealing with the public in the Z Zone, and (as will be evident from paragraph 32) the task is one requiring an ability to inspire confidence and the highest qualities of firmness and tact. The work might be undertaken by post or deputy post wardens from areas unaffected by fallout; but it is one for which police officers would be particularly well suited.

The clearance base

21 The essential facilities required for a clearance base are:

(a) Good communications.

(b) Access to adequate P.O.L. supplies.

(c) Hardstanding for the vehicles.

(d) Accommodation for personnel.

(e) Feeding facilities (these might be provided in billets or by Welfare Section emergency feeding teams).

It should be possible for the facilities to be found on the outskirts of most towns. A large bus depot would be ideal.

HOME OFFICE

CIVIL DEFENCE
TRAINING MEMORANDUM No. 6

The Evacuation of Casualties

(*PROVISIONAL*)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1961

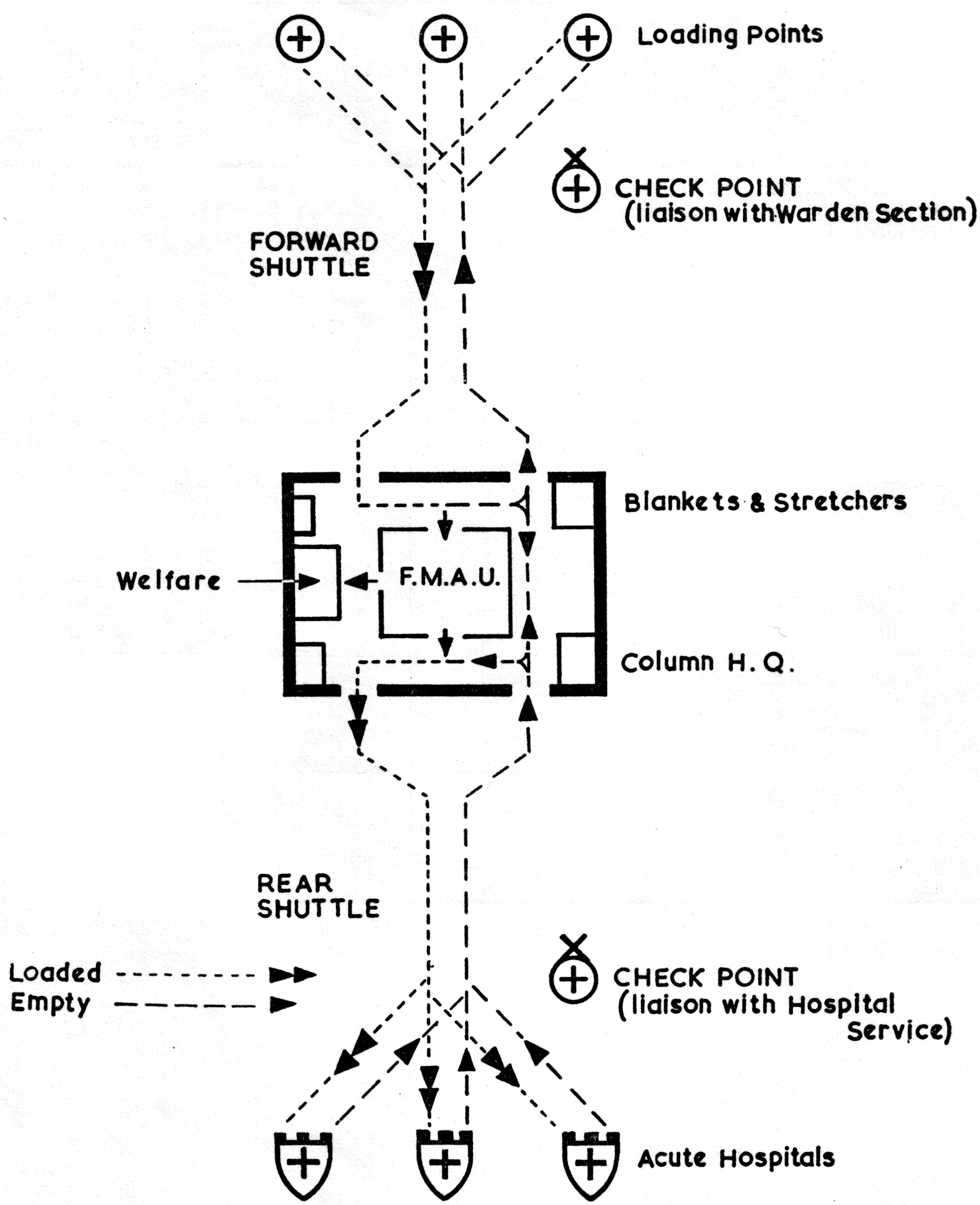
EIGHTPENCE NET

THE ORGANISATION OF AN AMBULANCE COLUMN

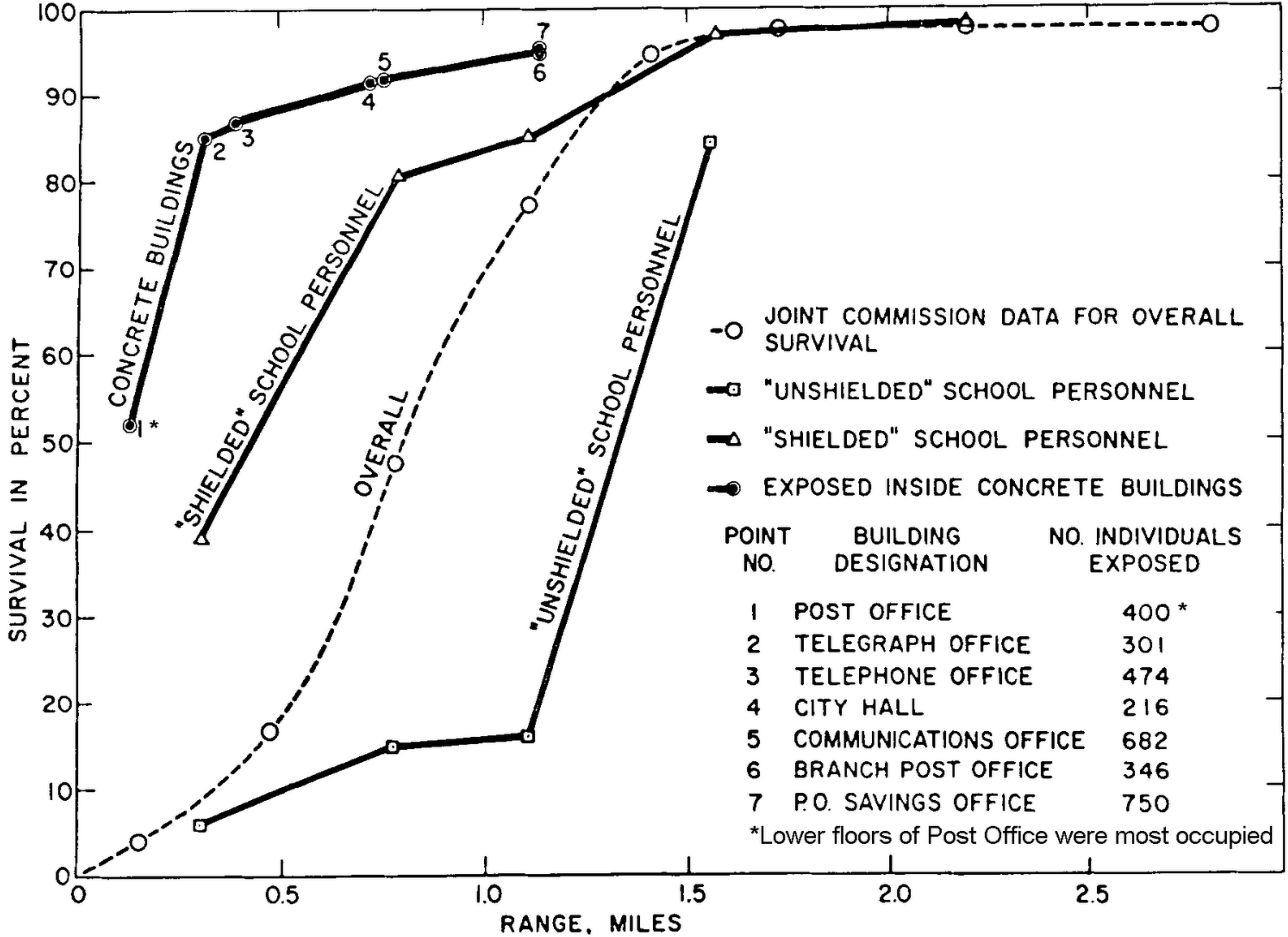
Appointment	*In charge of*	*Composition*	
		Personnel	*Vehicles*
Column Ambulance Officer Deputy Column Ambulance Officer	Ambulance Column comprising one Ambulance Company and one First Aid Company	334 (including drivers for staff cars and D.Rs.)	72 Ambulances 18 Personnel and Equipment Vehicles 10 Staff cars 10 Motor cycles
Company Ambulance Officer Deputy Company Ambulance Officer	Ambulance Company comprising four Ambulance platoons	187 (including drivers for staff cars and D.Rs.)	72 Ambulances 5 Staff cars 4 Motor cycles
Company First Aid Officer Deputy Company First Aid Officer	First Aid Company comprising three First Aid platoons	141 (including drivers for staff cars and D.Rs.)	18 Personnel and Equipment Vehicles 4 Staff cars 3 Motor cycles
Platoon Ambulance Officer Deputy Platoon Ambulance Officer	Ambulance platoon comprising three Ambulance detachments	45 (including driver for staff car)	18 Ambulances 1 Staff car
Platoon First Aid Officer Deputy Platoon First Aid Officer	First Aid platoon comprising six First Aid Parties	45 (including driver for staff car)	6 Personnel and Equipment Vehicles 1 Staff car
Ambulance Detachment Leader Deputy Ambulance Detachment Leader	Ambulance detachment	14	6 Ambulances
First Aid Party Leader Deputy First Aid Party Leader	First Aid party	7 (including driver)	1 Personnel and Equipment Vehicle

Note: Personnel and Equipment Vehicles (PEVs) Staff cars and motor cycles will not be issued for training purposes.

THE MOVEMENT OF AMBULANCES



F.M.A.U. = FORWARD MEDICAL AID UNIT (TRAINED TO APPLY PLASTER OF PARIS TO BROKEN LIMBS, ETC.)



Percentage of survivors as a function of range from Ground Zero (Hiroshima). (Ref. Joint Commission Report, Vol. VI, Document NP-3041.)

In Hiroshima, only 0.9% (17 burns) of 1,881 burns were due to ignited clothing, and only 0.7% (15 burns) were due to burns by firestorm flames!

TABLE 8.3A

Number of Persons with Burns from Different Causes (Tokyo Imperial University's First Survey, October–November 1945)

Distance from Hypocenter (km)	Secondary Burns† From Clothes on Fire	Secondary Burns† By Flame	Total Burns
0.6–1.0	3 (3.3)		89
1.1–1.5		1 (1.1)	327
1.6–2.0	4 (0.5)	4 (1.2)	717
2.1–2.5		6 (0.8)	558
2.6–3.0	5 (0.8)	3 (0.5)	140
3.1–3.5	4 (2.8)	1 (0.7)	41
3.6–4.0	1 (2.4)		4
Total	17 (0.9)	15 (0.7)	1,881

* Primary burns are burns by thermal rays from the A-bomb.
† Secondary burns are burns by fire other than thermal rays.
‡ Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Note: there were 5 burns cases within 0.6 km, all primary

TABLE 8.3B

Region of Burns

	Head		Face		Neck		Total	
	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors
Number of persons	179 (11.7)*	44 (12.3)	1,030 (67.4)	127 (35.7)	643 (42.1)	78 (21.9)	1,526	355
Total	223 (11.8)		1,157 (61.5)		721 (38.3)		1,881	

* Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981 by the Japanese Committee for the Compilation of Materials on Damage Caused by Atomic Bombs

SURVIVAL IN WOODEN AND CONCRETE BUILDINGS, HIROSHIMA

TABLE 7.3

Casualties among the Groups Exposed to the Atomic Bomb inside $\boxed{\textit{Wooden}}$ *Houses, Hiroshima*

Name of Building	Structure	Distance and Direction from Hypocenter (km)	Number Exposed	Mortality Rate (%)
Lodging for an itinerant theatrical troupe	Two-story	0.7 E	17	100.0
Second Hiroshima Army Hospital	Single-story	$\boxed{1.0\ N}$	402	$\boxed{75.3}$

Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 25.

TABLE 7.4

Casualties among the Groups Exposed to the Atomic Bomb inside $\boxed{\textit{Concrete}}$ *Buildings, Hiroshima*

Name of Building	Structure	Direction and Distance from Hypocenter (km)	Number Exposed	Mortality Rate (%)
The Bank of Japan, Hiroshima Branch	three-story	0.4 SE	75	57.3
Broadcasting Station	two-story	$\boxed{1.0\ E}$	31	$\boxed{6.5}$
Communication Bureau	four-story	1.4 N	245	6.1
Japan Red Cross Hospital, Hiroshima	three-story	2.0 S	480	0.4

* While the total number of exposed is known, it has not been possible to determine how many died instantly or soon after the explosion.
Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 26.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981

Sir,

18th April, 1950.

Civil Defence Act, 1948
Regulations relating to the Evacuation of the
Civil Population (Statutory Instrument 1949, No.2147)

1. I am directed to refer to Circular 81/49 (Wales) of 23rd August, 1949, which transmitted for your information a copy of the draft Civil Defence (Evacuation and Care of the Homeless) Regulations, 1949. These Regulations have now been approved by both Houses of Parliament and are now operative. I am now to enclose a copy of a Memorandum on Evacuation (Memo Ev.1 (1950) which contains an outline of the general plan for the transfer of certain sections of the civilian population from the more densely populated areas in the event of war or the imminence of war. For the purpose of this transfer the system developed in the 1939/45 war has been adopted, whereby the country is divided into evacuation, neutral and reception areas

9. ESTIMATES OF ACCOMMODATION IN RECEPTION AREAS

In order that specific allocations may be worked out and each Reception Authority informed of the number of members of the priority classes for whom their plans should provide, it is requested that every Reception Authority will prepare an estimate of the total number of habitable rooms in their area. The Minister of Health has been advised by the Associations of Local Authorities that the Receptio Authorities (who are the Housing Authorities) will be able to make reasonably accurat estimates from information already available to them. The estimate should include all rooms normally used in the locality either as living rooms or as bedrooms. I am to ask that this estimate may be forwarded to the Department, not later than 30th June, 1950.

10. The Department do not consider that any useful purpose would be served by carrying out at this stage a detailed survey of the accommodation which could be made available for evacuees such as was undertaken in January, 1939.

IV. LATER ACTION

11. When the specific allocations of the number of members of the priority classes for whose reception arrangements should be made in each reception area have been decided, it will be possible to link each Reception Authority with a particular Evacuation Authority. When the plan has been developed in this way, or as the

---

14. The Memorandum on Evacuation (Memo Ev.1 (1950) has been placed on sale. Further copies may be purchased direct from His Majesty's Stationery Office or from any bookseller.

I am, Sir,
Your obedient Servant,

William Thomas

The Clerk of the Council.

LINKING OF EVACUATION AND RECEPTION AREAS FOR ORGANISED EVACUATION

MERSEYSIDE GROUP

EVACUATION AREAS

Liverpool C.B.	Bebington B.
Birkenhead C.B.	Widnes B.
Wallasey C.B.	Litherland U.D.
Bootle C.B.	Northwich U.D.
Crosby B.	Runcorn U.D.
	Ellesmere Port U.D.

Estimated Civil Population, 1,320,000 *

Estimated number of members of priority classes, 376,300

ASSOCIATED RECEPTION AREAS

County	Local Authority		Estimated Civil Population *
Cheshire	Chester C.B.		48,000
	Alsager U.D.		5,000
	Hoole U.D.		9,000
	Hoylake U.D.		26,000
	Middlewich U.D.		6,000
	Nantwich U.D.		9,000
	Neston U.D.		9,000
	Sandbach U.D.		9,000
	Winsford U.D.		12,000
	Wirral U.D.		17,000
	Chester R.D.		19,000
	Nantwich R.D.		26,000
	Tarvin R.D.		15,000
		Total	210,000
Lancashire	Blackpool C.B.		152,000
	Southport C.B.		84,000
	Colne B.		20,000
	Fleetwood B.		26,000
	Nelson B.		34,000
	Adlington U.D.		4,000
	Barrowford U.D.		5,000
	Brierfield U.D.		7,000
	Formby U.D.		9,000
	Kirkham U.D.		4,000
	Ormskirk U.D.		21,000
	Padiham U.D.		10,000
	Poulton le Fylde U.D.		8,000
	Preesall U.D.		2,000
	Skelmersdale U.D.		6,000

* Registrar-General's estimate of civil population as at mid-1948.

ASSOCIATED RECEPTION AREAS (Contd.)

County	Local Authority		Estimated Civil Population *
Cardigan	Aberystwyth B.		10,000
	Cardigan B.		3,000
	Lampeter B.		2,000
	Aberayron U.D.		1,000
	New Quay U.D.		1,000
	Aberayron R.D.		9,000
	Aberystwyth R.D.		10,000
	Teifiside R.D.		10,000
	Tregaron R.D.		5,000
		Total	51,000
Denbigh	Colwyn Bay B.		23,000
	Denbigh B.		8,000
	Ruthin B.		4,000
	Wrexham B.		29,000
	Abergele U.D.		7,000
	Llangollen U.D.		3,000
	Llanrwst U.D.		3,000
	Aled R.D.		7,000
	Ceiriog R.D.		7,000
	Hiraethog R.D.		5,000
	Ruthin R.D.		10,000
	Wrexham R.D.		62,000
		Total	168,000
Flint	Flint B.		14,000
	Buckley U.D.		8,000
	Connah's Quay U.D.		7,000
	Holywell U.D.		8,000
	Mold U.D.		6,000
	Prestatyn U.D.		8,000
	Rhyl R.D.		19,000
	Hawarden R.D.		32,000
	Holywell R.D.		22,000
	Overton R.D.		6,000
	St. Asaph R.D.		8,000
		Total	138,000
Merioneth	Bala U.D.		1,000
	Barmouth U.D.		2,000
	Dolgelley U.D.		2,000
	Festiniog U.D.		7,000
	Towyn U.D.		3,000
	Deudraeth R.D.		7,000
	Dolgelley R.D.		8,000
	Edeyrnion R.D.		4,000
	Penllyn R.D.		3,000
		Total	37,000

[redacted]

TM 23-200/OPNAV INSTRUCTION 03400.1C/AFM 136-1/FMFM 11-2

THIS PUBLICATION SUPERSEDES TM 23-200, OPNAV INSTRUCTION 03400.1B, AFM 136-1/NAVMC 1104 REV, NOVEMBER 1957, INCLUDING CHANGE 1, 24 JUNE 1960 AND CHANGE 2, 3 OCTOBER 1960 THERETO.

105483

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CAPABILITIES OF NUCLEAR WEAPONS [U]

CLASSIFICATION CANCELLED *
WITH DELETIONS
BY AUTHORITY OF DOE/OC
J. Diaz 1/29/91
REVIEWED BY DATE
* LTR DNA SWISHER TO DOE MA-235, 3-19-90
Kahn 2/13/91

United States Government Printing Office
Washington: 1964

[redacted]

GROUP-3
Downgraded at 12 year intervals;
Not automatically declassified.

Table 7-1 Estimated Casualty Production in Structures for Various Degrees of Structural Damage

Structural damage	Killed outright	Serious injury (hospitalization)	Light injury (No hospitalization)
		Percent*	
1-2 story brick homes (high explosive data):			
Severe damage	25	20	10
Moderate damage	<5	10	5
Light damage		<5	<5
Reinforced-concrete buildings (Japanese data, nuclear):			
Severe damage	100		
Moderate damage	10	15	20
Light damage	<5	<5	15

*These percentages do not include the casualties that may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentage of casualties expected at the maximum range where the specified structural damage occurs. For the distances at which these degrees of damage occur for various yields see Chapter 8.

example, although such effects as capacitor discharge are usually referred to as transient effects, the time constant for recovery of the capacitor to its normal operating potential may be so long that recovery may not be effected before the mission of the system involved is complete. In this instance the effect would be classified as permanent damage even though the capacitor itself would have eventually completely recovered.

ELECTROMAGNETIC PULSE RADIATION DAMAGE

a. General. Permanent damage due to overheating or puncturing of insulation is possible where the electromagnetic pulse energy is high, where the induced voltage triggers an electrical fault and the damage energy is supplied by the affected system, or where the electromagnetic pulse energy is carried for some distance along a cable or line as a power surge.

Interruption of service may occur where the voltage induced in a cable or line causes fuses to blow or circuit breakers to trip. This may take place many miles away from the point of detonation due to transmission of the surge. An interruption could also result if an electronically stored program were subjected to a strong enough transient electromagnetic field to scramble it.

Transient disturbances to electronic systems may occur in several ways. The electromagnetic pulse may be received via the signal or power lines acting as antennae. Or, the low frequency portion of the pulse may penetrate the enclosures and directly induce transient signals in the circuits.

Many instances of all three kinds of damage, i.e., permanent, interruptive and transient, have been experienced. So far, little if any, correlation of damage with measured electromagnetic field strengths has been established. This has been the result of factors previously described, and of uncertainty of the point where electromagnetic pulse pickup actually occurred in cases where many cables and lines were in use for power, signal, control and mechanical purposes.

b. Power System Damage. Very regular zero-time tripping of power circuit breakers at a substation more than 30 miles away was observed on one series of tests. Standby personnel were always posted to reset the breakers to keep electrical equipment functioning. Within a mile of ground zero, pinholes in underground cable insulation have frequently been found. Such cables carried up to 4160 volts.

At power distribution stations, porcelain cutouts have been observed to arc over and the fuses have often blown. At other stations power transformers have been shorted internally or have had insulating bushings destroyed. Ordinary lightning protective devices provided inadequate protection against the electromagnetic pulse, in those cases.

c. Signal System Damage. Damage to signal systems has also been frequent in the form of burned or fused relays, potentiometers, cable insulation and conductors, as well as blown or damaged meters. In many instances, reviews of the circuits have shown that induced energy caused the damage, rather than triggered system energy. Free ends of cable pairs have often arced and melted.

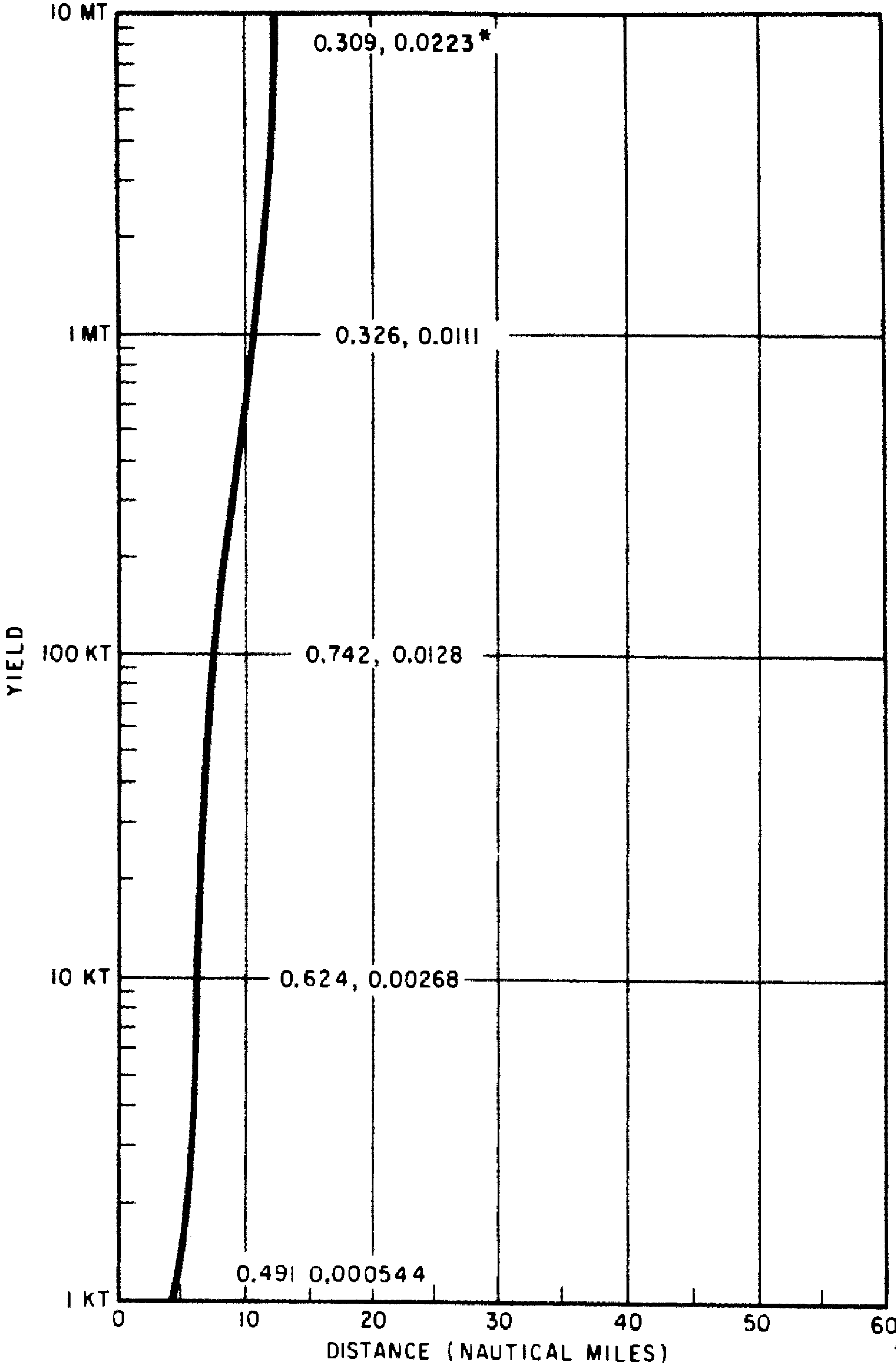
d. Electronic System Damage. Oscilloscope presentations have frequently been disturbed or obliterated, even as far as 11 miles from ground zero.

Pulse counters in a timing circuit have been scrambled directly by the induced field (this effect has actually been duplicated in a simulation test in which a 1 mfd capacitor was charged to several thousand volts, then discharged into 10 turns of wire wound around the cabinet). Memory circuits employing magnetic elements may be vulnerable to the magnetic field, *H*, in a direct manner, as well as to the time derivative of the field.

Elaborate protective measures against electromagnetic effects have been devised, on occasion, such as extensive grounding plate systems, double-walled screen rooms, precautions against forming loops, and special bonding. These measures appeared effective on certain occasions, but on others, when higher yield weapons were tested, the precautions did not always suffice.

General recommendations for protection against electromagnetic pulse radiation damage cannot yet be made. Protective measures to be taken will depend principally upon the nature of the target and the degree of protection required.

[redacted]



*EACH PAIR OF VALUES INDICATE, RESPECTIVELY, CALORIES AT THE CENTER OF THE IMAGE AND CALORIES ON THE LENS SURFACE

SEA LEVEL (BURST AND OBSERVER)
WATER VAPOR PRESSURE: 5mm HG
PUPILLARY DIAMETER: 3mm

Figure 7-3. Yield vs. Maximum Distance at which a Retinal Burn will be Formed. Visibility 10 Statute Miles; Standard Normal Day, and Daytime Adapted Eye

13-5 FIRE IN URBAN AREAS. The employment of an air burst weapon over urban areas may produce, besides blast damage, mass fires which, under proper conditions, materially increase the degree and extent of damage. The behavior of such fires, whether they are of primary or secondary origin, follows the pattern of fires in forest and wildland areas. The burning potential for urban areas varies with weather conditions, much as for wildlands; however, the fire season as such is not as pronounced as in wildlands. During those seasons when weather conditions may reduce exterior potentials to zero, dwellings are usually heated, so that interior fuels are dried out. Fire incidence and subsequent fire buildup depend also upon the amount and distribution of flammable material used in interior furnishing and building construction, the incidence of interior kindling fuels, and the relative cleanliness of the living habits of the population.

13-6 Ignition Points. A survey of metropolitan areas in the United States indicates that the incidence of exterior ignition points can be correlated with urban land use. Table 13-1 presents a relative tabulation based on exterior kindling fuels. Newspapers and other paper products account for 70 percent of the total, and dry grass and leaves account for another 10 percent in residential areas. Most other exterior kindling fuels are present in small percentages or require radiant exposures in excess of 10 cal/cm^2 for ignition. Weathered and badly checked fences and building exteriors that contain appreciable dry rot constitute an ignition hazard. The tabulation presented in table 13-1 is not representative of European cities and other areas where fuel is at a premium, or where extensive use is made of stone, brick, masonry, and heavy timber construction. Multistory buildings and narrow streets reduce both interior and exterior primary ignitions, because such ignitions are proportional to the amount of sky seen from the location of the probable ignition point.

Table 13-1 Relative Incidence of Ignitions in Metropolitan Areas of the United States by Land Use (Based on Exterior Kindling Fuels).

Land use	Relative incidence
Downtown retail	1.0
Large manufacturing*	1.4
Good residential	1.6
Small manufacturing	3.8
Poor residential	5.2
Neighborhood retail	5.5
Waterfront areas	8.0
Slum residential	11.7
Wholesaler	15.1

* May be likened to a typical fixed military installation in the Z.1.

13-7 Humidity Effects. Because paper is the major exterior kindling fuel and is also an important interior fuel, the extent of ignitions may be estimated from the minimum radiant exposure requirements for newspaper. Figure 13-1 shows the radiant exposure required to ignite darkly printed picture areas and printed text areas of newspaper at 50% relative humidity. The effect of relative humidity on the ignition of this cellulosic fuel can be estimated by multiplying the ignition radiant exposures for the dry material by the factor, $1 + 0.005\,H$, where H is the relative humidity in percent. Maximum fire effects occur during daily periods of lowest relative humidity, usually mid-afternoon. Guides for estimating urban burning potentials are given in figures 13-2 and 13-3. Figure 13-2, which gives burning potential for urban areas when central heating is not in use, represents approximate values of wind speed and average daytime relative humidity conditions corresponding to low, dangerous, and critical burning potentials according to the following definitions:

Low. Slow burning fires; fire can be controlled at will. Control action can be on unit structure basis.

Dangerous. Fires burn rapidly; individual building fires combine to form an area fire. Organized action needed to confine fire to area originally ignited.

Table 13-2 Critical Radiant Exposures for Damage to Various Materials

ambient relative humidity of 65 percent

Material	Weight (oz/sq yd)	Color	Effect on Material	Radiant Exposure (cal/cm²) 40 kt	1 mt	10 mt
Clothing Fabrics						
Cotton	8	White	Ignites	32	48	85
		Khaki	Tears on flexing	17	27	34
			Ignites	20	30	39
		Olive	Tears on flexing	9	14	21
			Ignites	14	19	21
		Dark Blue	Tears on flexing	11	14	17
			Ignites	14	19	21
Cotton-nylon Mixture	5	Olive	Tears on flexing	8	15	17
			Ignites	12	28	53
Wool	8	White	Tears on flexing	14	25	38
		Khaki	Tears on flexing	14	24	34
		Olive	Tears on flexing	9	13	19
		Dark Blue	Tears on flexing	8	12	18
	20	Dark Blue	Tears on flexing	14	20	26
Rainwear (double neo-prene coated nylon twill)	9	Olive	Begins to melt	5	9	13
			Tears on flexing	8	14	22
Tinder Materials						
Paper, bond, typing, new (white)			Ignites	24	30	50
Newspaper, printed text			Ignites	6	8	15
Newsprint, dark picture area			Ignites	5	7	12
Paper, kraft, single sheet (tan)			Ignites	10	13	20
Rags (black, cotton)			Ignites	10	15	20
Rags (black, rayon)			Ignites	9	14	21
Tent Material						
Canvas, white, 12 oz/sq yd			Ignites	13	28	51
Canvas, OD, 12 oz/sq yd			Ignites	12	18	28
Aluminum aircraft Skin (0.020 in. thick) coated with 0.002 in. of standard white aircraft paint			Blisters	15	30	40
Sandbags, cotton, canvas, dry, filled			Failure	10	18	32
Construction Materials						
Roll Roofing, mineral surface			Ignites	—	>34	>116
Roll Roofing, smooth surface			Ignites	—	30	77
Plywood, douglas fir			Flaming during exposure	9	16	20
Sand, coral			Explosion*	15	27	47
Sand, siliceous			Explosion*	11	19	35
Rubber, pale latex			Ignites	50	80	110
Rubber, black			Ignites	10	20	25

* Popcorning

[redacted]

Table 7-2 Radiant Exposures for Burns Under Clothing

Clothing	Burn	40 kt	1 mt	10 mt
		Radiant exposures[1,2]		
Bare skin	none	2.0	2.6	2.9
	1°	2.6	3.1	3.5
	2°	4.6	6.3	7.0
Summer uniform (2 layers of light porous fabric)	none	5	6	7
	1°	10	16	21
	2°	12	20	26
Winter uniform (2 to 5 layers of tightly woven fabric)	none	7	10	12
	1°	13	21	29
	2°	16	26	36
Sub-artic and arctic (3 to 8 layers of tightly woven fabric)[3]	none	15	25	40
	1°	15	25	40
	2°	15	25	40

[1] Expressed in cal/cm^2 incident on skin or outer surface of clothing when the inner layer of the clothing is spaced 0.5 cm from the skin and when at least the first 70% of the thermal pulse is received normal to the surface.

[2] These values are sensitively dependent on many variables and are probably correct to within ±50% for the range of normal military situations.

[3] Burns to personnel wearing these heavy uniforms will occur only by contact with flaming or glowing outer garments. Some systems require in excess of 100 cal/cm^2 to produce burns by direct transmission of heat through the fabrics.

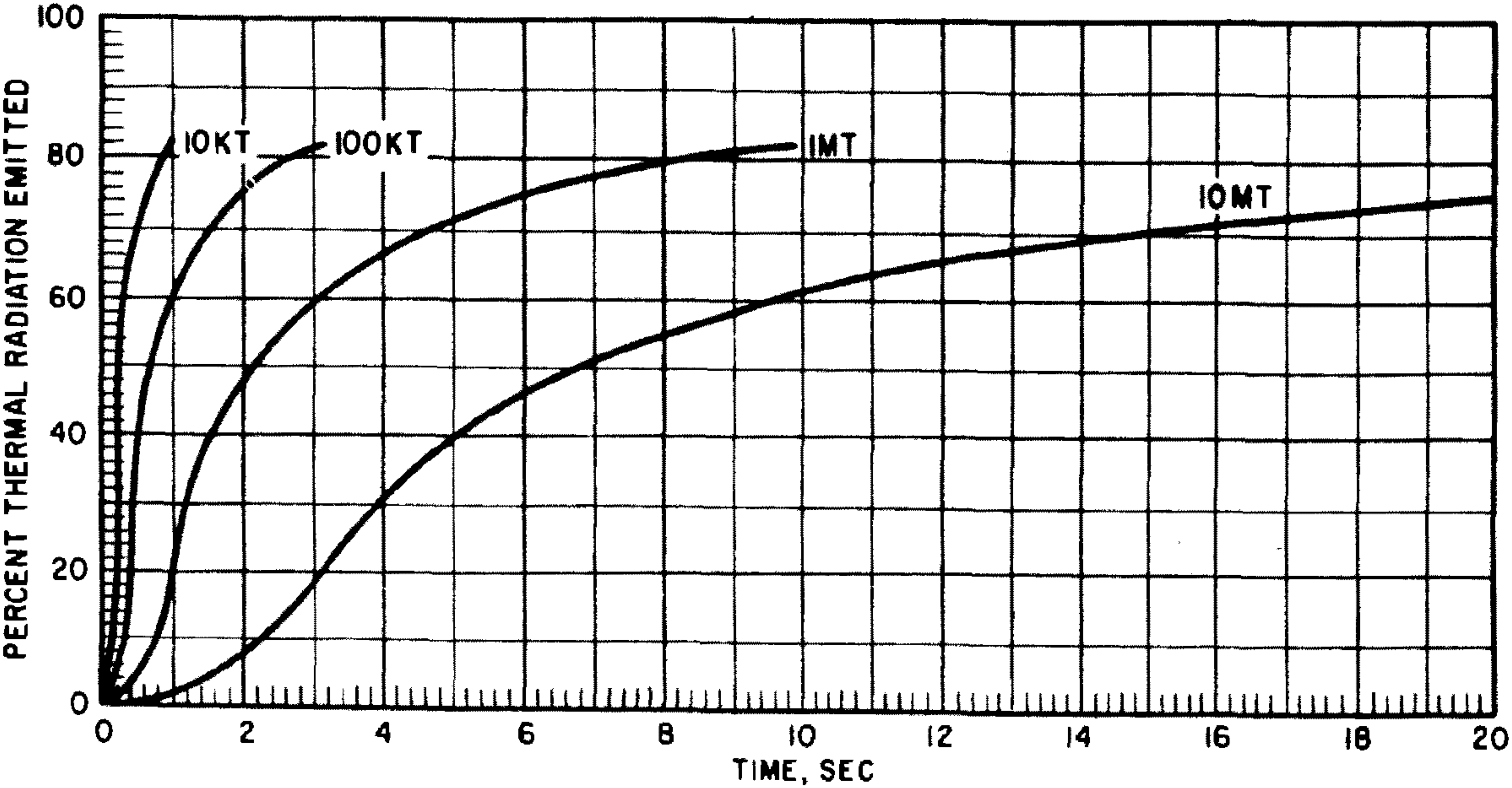


Figure 7-2. Percent Thermal Radiation Emitted vs. Time for Detonations Within the Atmosphere

Teapot-MET (1955)

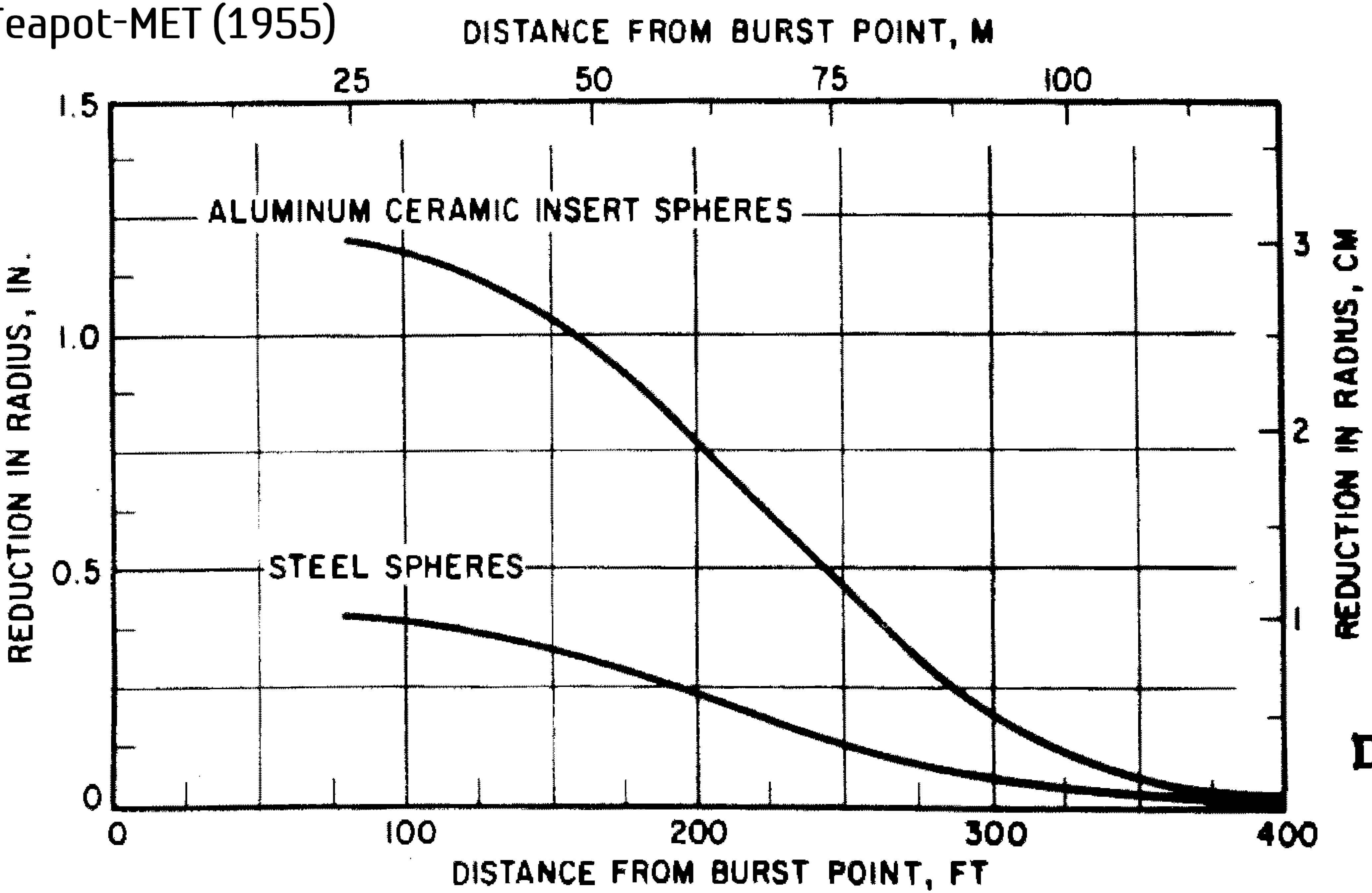


Figure 13-5. Reduction of Sphere Radius with Distance from a 23-kt Burst for Aluminum, Steel, and Ceramic Insert Spheres

Table 7-4 Summary of Clinical Effects of Acute Ionizing Radiation Dose

		Therapeutic range			Lethal range	
		100-200 rems	200-600 rems	600-1000 rems	1000-5000 rems	Over 5000 rems
Range	Subclinical range	Clinical surveillance	Therapy effective	Therapy promising	Therapy palliative	
Incidence of vomiting	None	100 rems: 5% 200 rem:: 50%	300 rems: 100%	100%	Up to 100%	
Delay time	—	3 hours	2 hours	1 hour	30 minutes	
Leading organ	None	Hematopoietic tissue			Gastro-intestinal tract	Central nervous system
Characteristic signs	None	Moderate leukopenia	Severe leukopenia; purpura; hemorrhage; infection. Epilation above 300 rems.		Diarrhea; fever; disturbance of electrolyte balance	Convulsions; tremor; ataxia; lethargy
Critical period postexposure	—	—	4 to 6 weeks		5 to 14 days	1 to 48 hours
Therapy	Reassurance	Reassurance, hematologic surveillance	Blood transfusion; antibiotics	Consider bone marrow transplantation	Maintenance of electrolyte balance	Sedatives
Prognosis	Excellent	Excellent	Good	Guarded	Hopeless	
Convalescent period	None	Several weeks	1-12 months	Long		
Incidence of death	None	None	0-80% (variable)	80-100% (variable)	95-100%	
Death occurs within	—	—	2 months		2 weeks	2 days
Cause of death	—	—	Hemorrhage; infection		Circulatory collapse	Respiratory failure; brain edema

Table 7-5 Dose Transmission Factors (Interior Dose/Exterior Dose)

Geometry	Gamma rays Initial	Gamma rays Residual	*Neutrons*[1]
Foxholes[2]	0.20	0.10	0.30
Underground—3 ft	0.04-0.05	0.0002	0.002-0.01
Builtup city area (in open)	—	0.70	—
Frame house	0.80	0.30-0.60	0.3-0.8
Basement	0.05-0.5	0.05-0.1	0.1-0.8
Multistory building:			
Upper	0.9	0.01	0.9-1.0
Lower	0.3-0.6	0.1	0.9-1.0
Blockhouse walls:			
9 in	0.1	0.007-0.09	0.3-0.5
12 in	0.05-0.09	0.001-0.03	0.2-0.4
24 in	0.01-0.03	0.0001-0.002	0.1-0.2
Factory, 200 x 200 ft	—	0.1-0.2	—
Shelter, partly above grade:			
With earth cover—2 ft	0.02-0.04	0.005-0.02	0.02-0.08
With earth cover—3 ft	0.01-0.02	0.001-0.005	0.01-0.05
Rough Terrain	—	0.4-0.8	—
Tanks: M-24, M-41, Tank Recov. Vehicle M-51, M-74	0.3-0.5	0.2	0.5-0.7
Tanks: M-26, M-47, M-48, T-43E1; Eng. Armd. Vehicles, T-39E2	0.2-0.4	0.1	0.3-0.6
Tractor, crawler, D8 w/blade	1.0	0.4	1.0
1/4-ton truck	1.0	0.8	1.0
3/4-ton truck	1.0	0.6	1.0
2-1/2-ton truck	1.0	0.5-0.6	1.0
Armd. Inf. Vehicle M-59, M-75. and 8P Twin 40mm Gun M-42	0.8-1.2	0.2-0.6	0.8-1.0
SP 105-mm howitzer M-52	0.6-0.8	0.4-0.6	0.8-1.0
Cruisers[3]			
Navigating Bridge	0.12-0.35	0.005-0.2	0.75
Superstructure Deck	0.008-0.25	0.0001-0.1	0.7
Main Deck	0.005-0.25	0.00003-0.1	0.7
Second Deck	0.0002-0.2	0-0.07	0.6
First Platform	0.0002-0.2	0-0.07	0.2-0.3
Second Platform	0.0001-0.10	0-0.01	0.05-0.15
Destroyer[3]			
Navigating Bridge	0.25-0.40	0.1-0.2	0.85
Superstructure Deck	0.015-0.40	0.00025-0.2	0.8-0.85 D
Main Deck	0.008-0.34	0.0001-0.2	0.75-0.8
First Platform	0.001-0.25	0-0.1	0.75-0.8
Second Platform	0.0005-0.20	0-0.07	0.5-0.75

[1] Estimated values.

[2] No line-of-sight radiation received.

[3] Assuming a beam-on orientation.

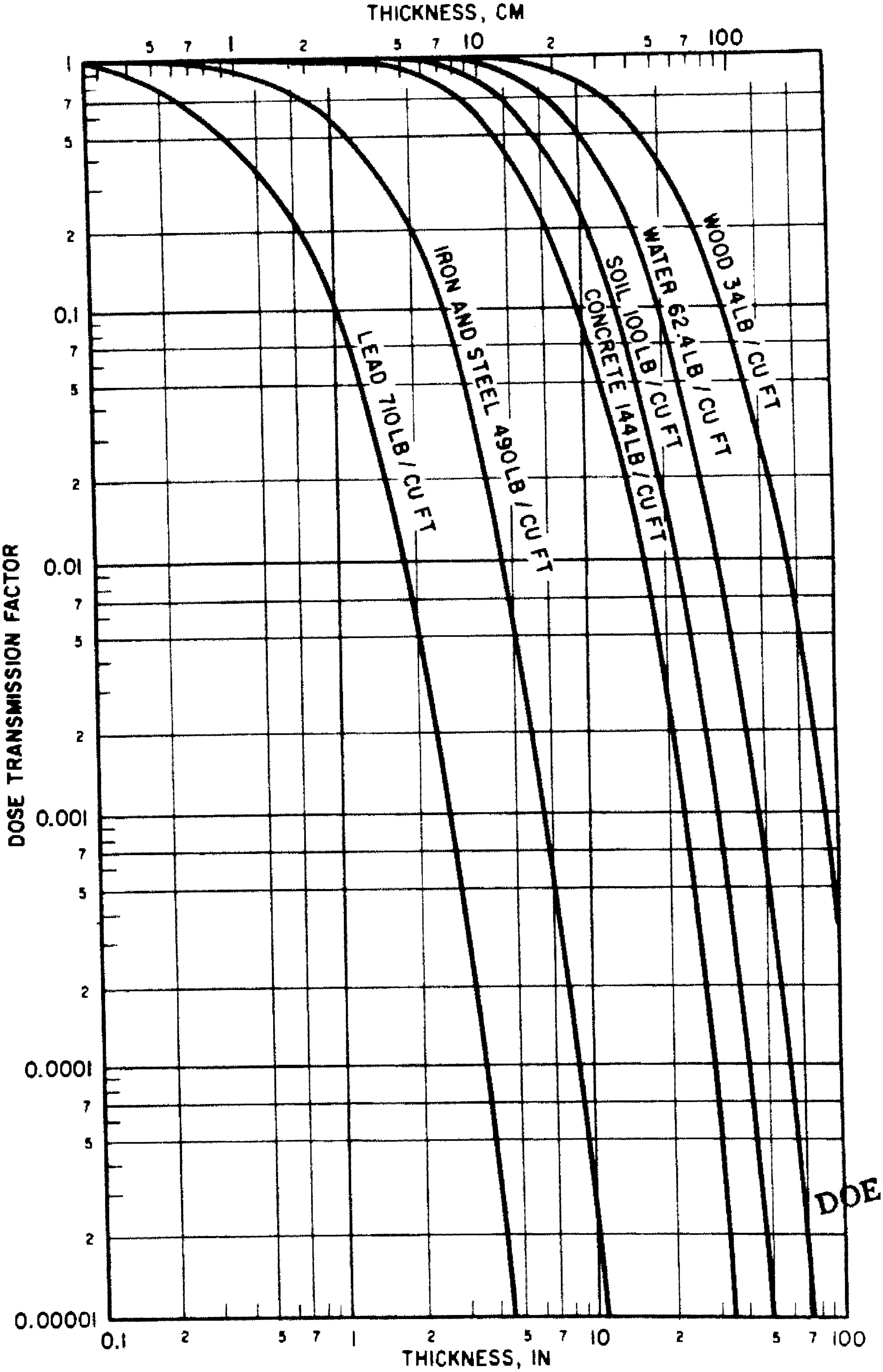


Figure 7-12. Shielding from Residual Gamma Radiation

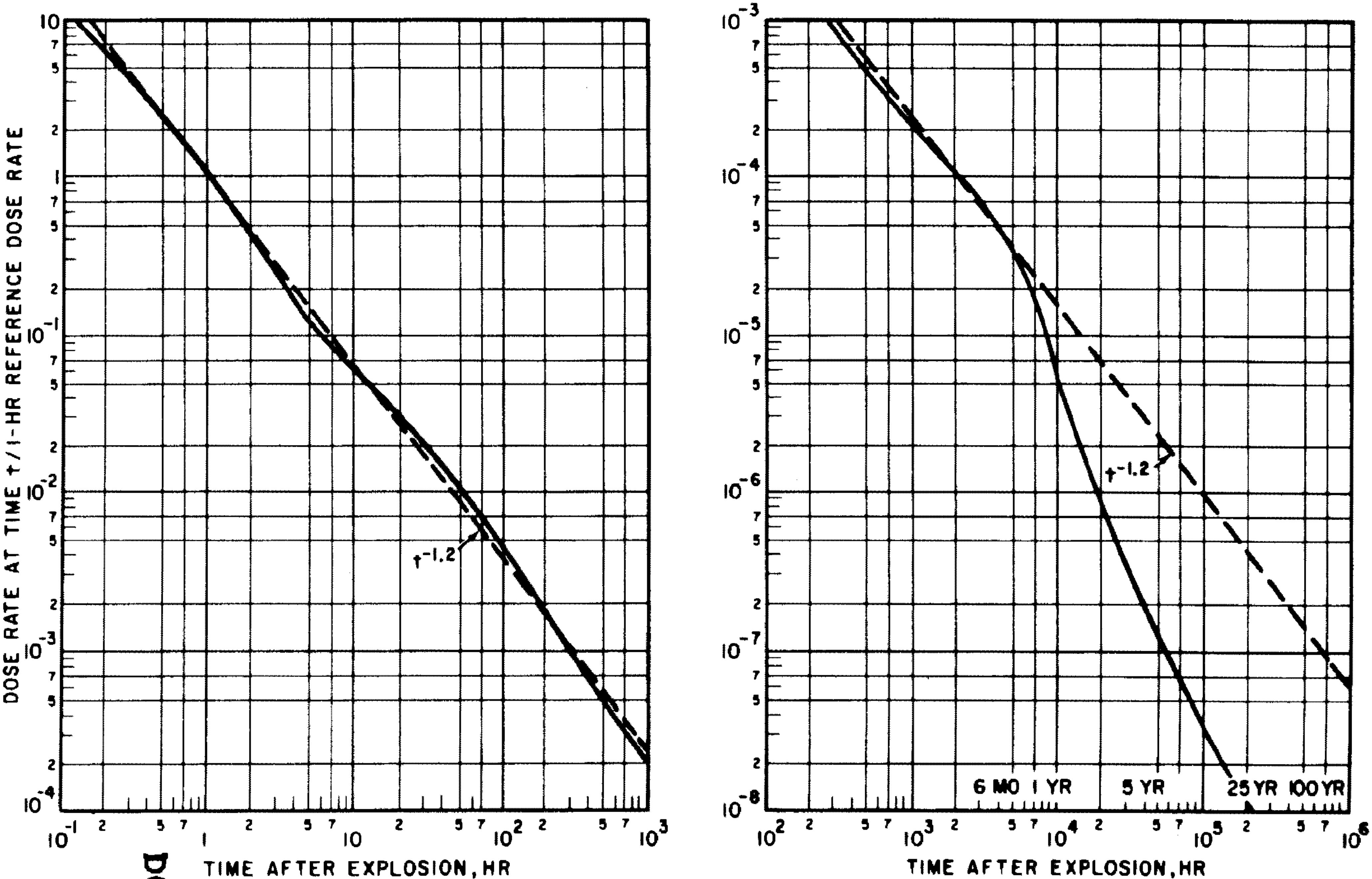


Figure 4-21. Fission-product Decay Factors Normalized to Unity, 1 hr after Detonation

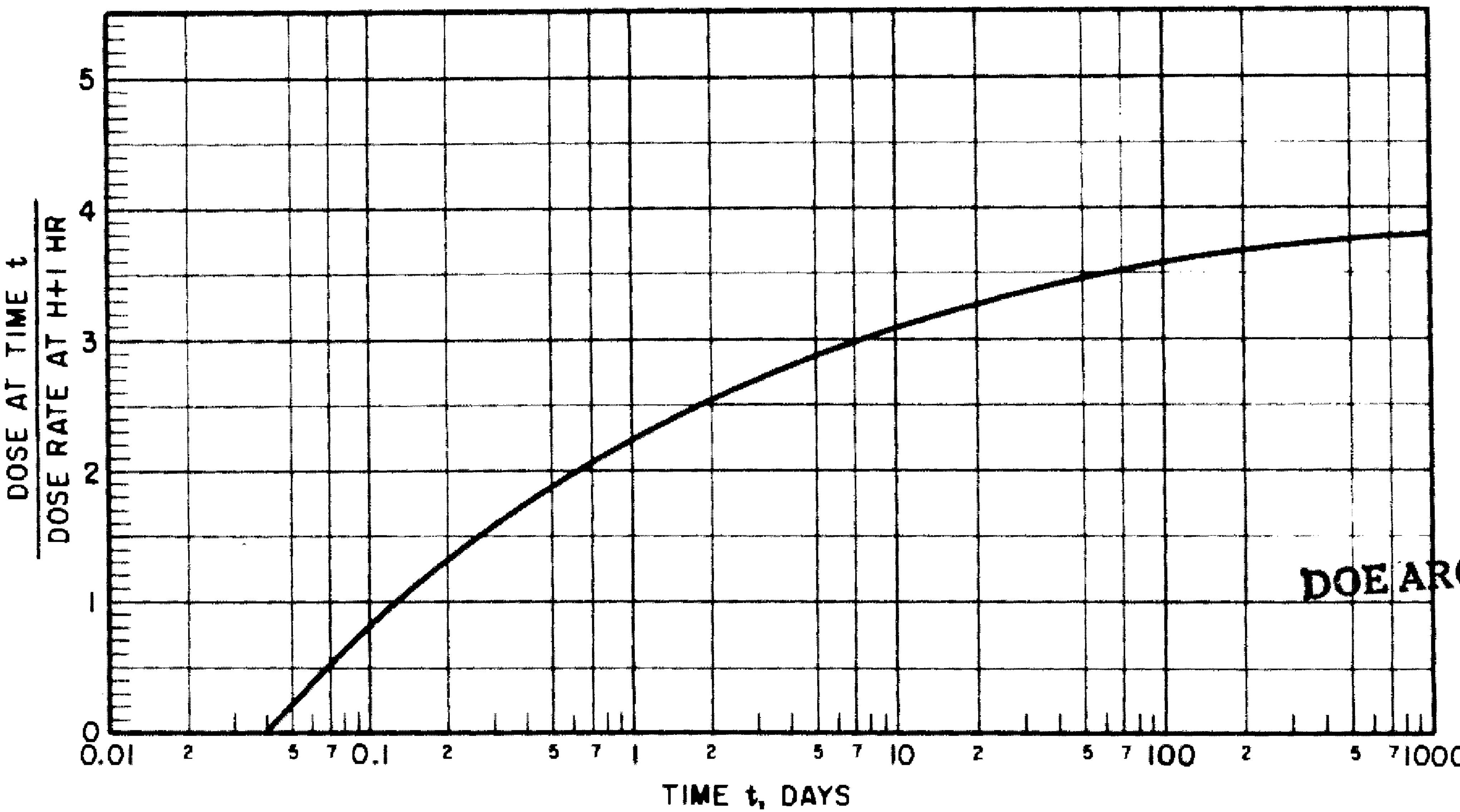


Figure 4-22. Normalized Theoretical Dose Accumulated in a Fallout-contaminated Area from $H + 1$ hr to $H + 1000$ Days

4-13 AIR BURST. The surface contamination effects of fallout from an air-burst weapon are militarily insignificant in most cases because the bomb cloud carries most of the radioactive bomb debris to high altitudes. In general, by the time this material can fall back to earth, dilution and radioactive decay decreases the activity to levels that are no longer militarily important. An exception may occur in the case of a small-yield weapon burst in the rain, where the scavenging effect of the precipitation may cause a rainout of radioactive material that will be hazardous to personnel located downwind and downhill, and outside the hazard area of initial radiation and other effects. Although the range of weapon yields for which rainout may become hazardous is not large, quantitative treatment of the problem is difficult. The contamination pattern on the ground depends upon the scavenging effect of precipitation on suspended fission products in the atmoshere, and the flow and ground absorption of rain water after reaching the ground.

Some of the factors that influence the scavenging effect are:

(1) Height and extent of the rain cloud

(2) Raindrop size and distribution

(3) Rate of rainfall

(4) Duration of precipitation

(5) Position of the nuclear cloud relative to the precipitation

(6) Hygroscopic character of the fission products

(7) Solubility of the fission products

(8) Size of the fission fragments

 [redacted]

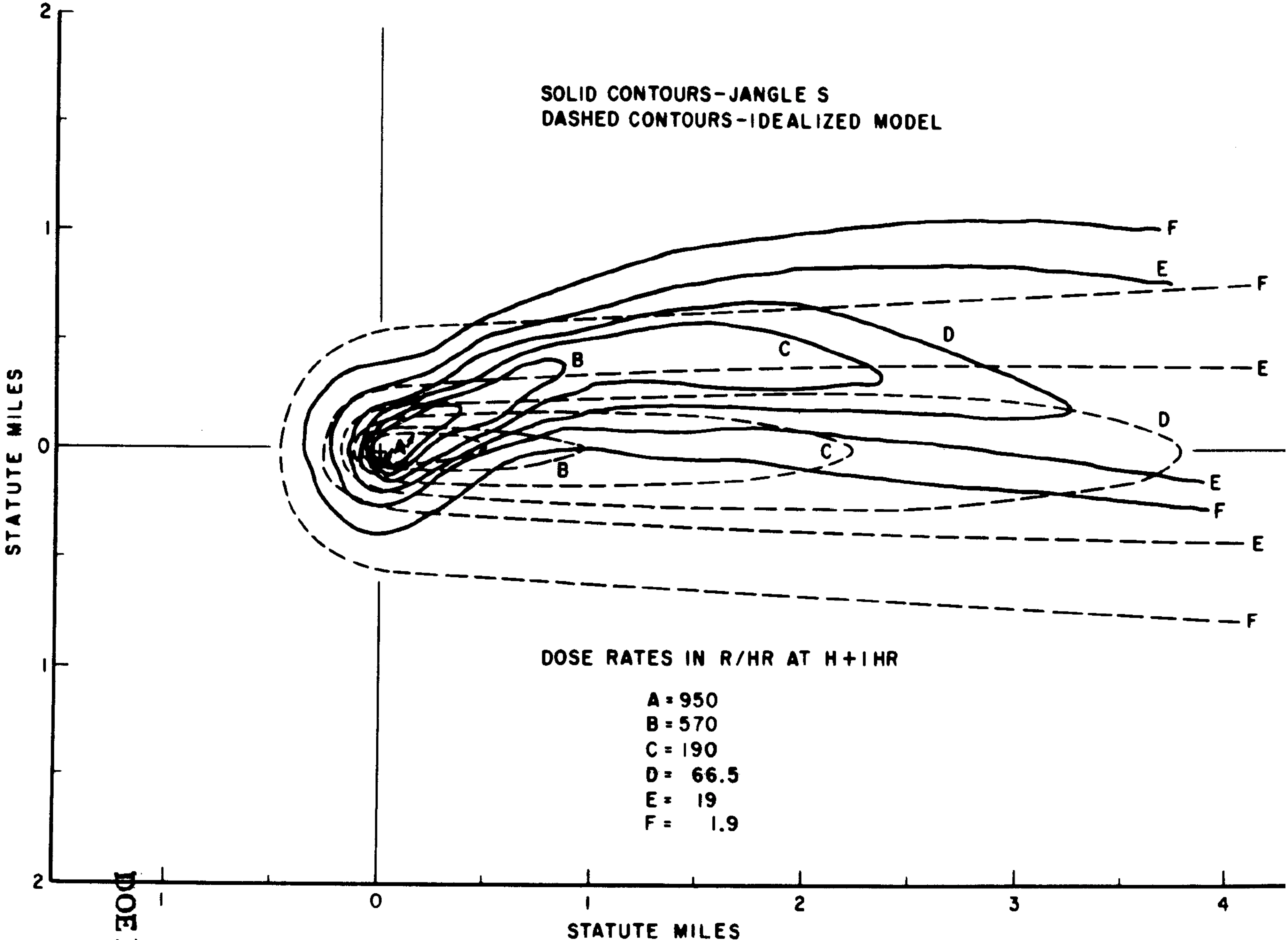


Figure 4-3. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1.2 kt and Effective Wind of 20 knots

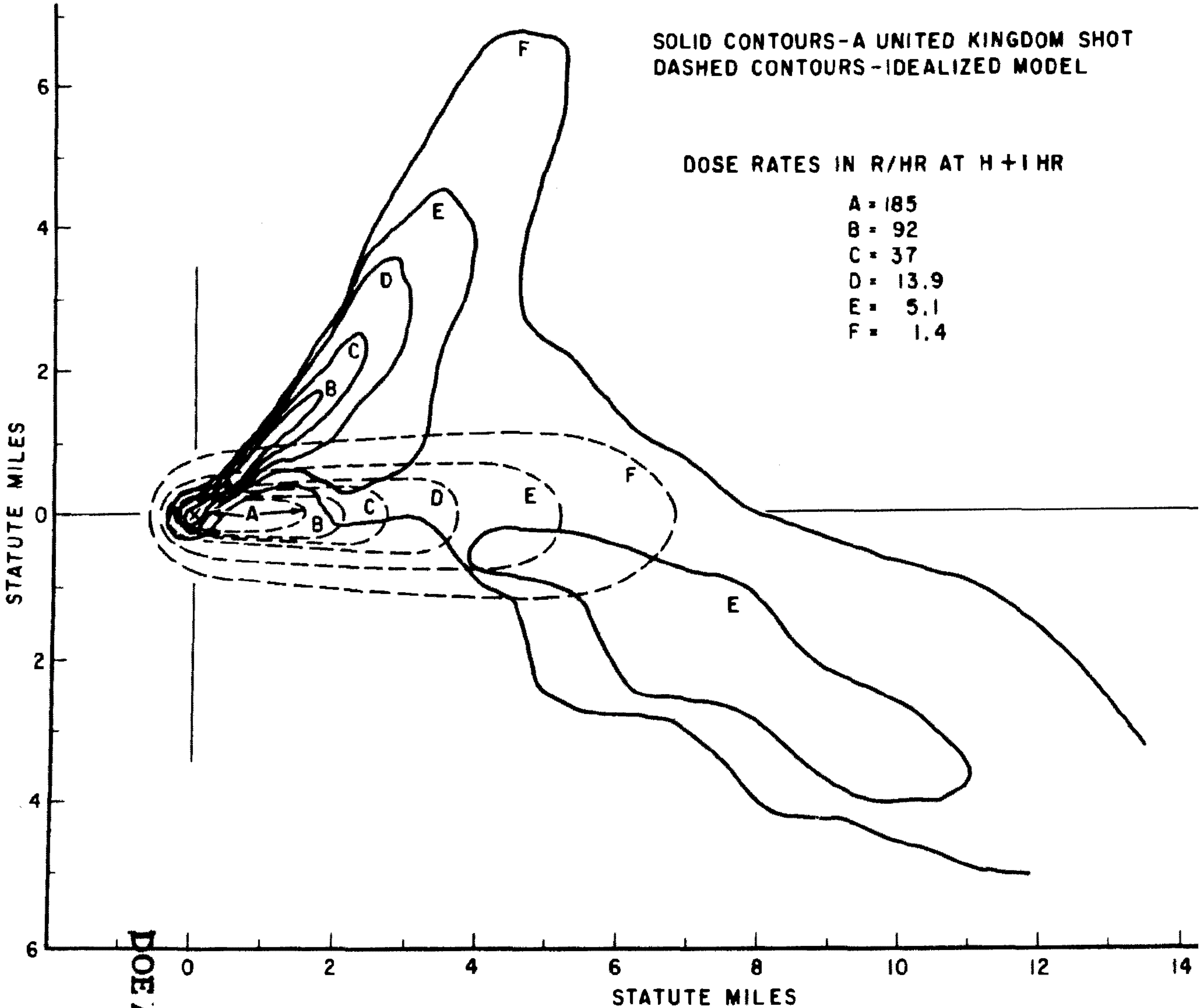


Figure 4-4. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1 kt and Effective Wind of 10 knots

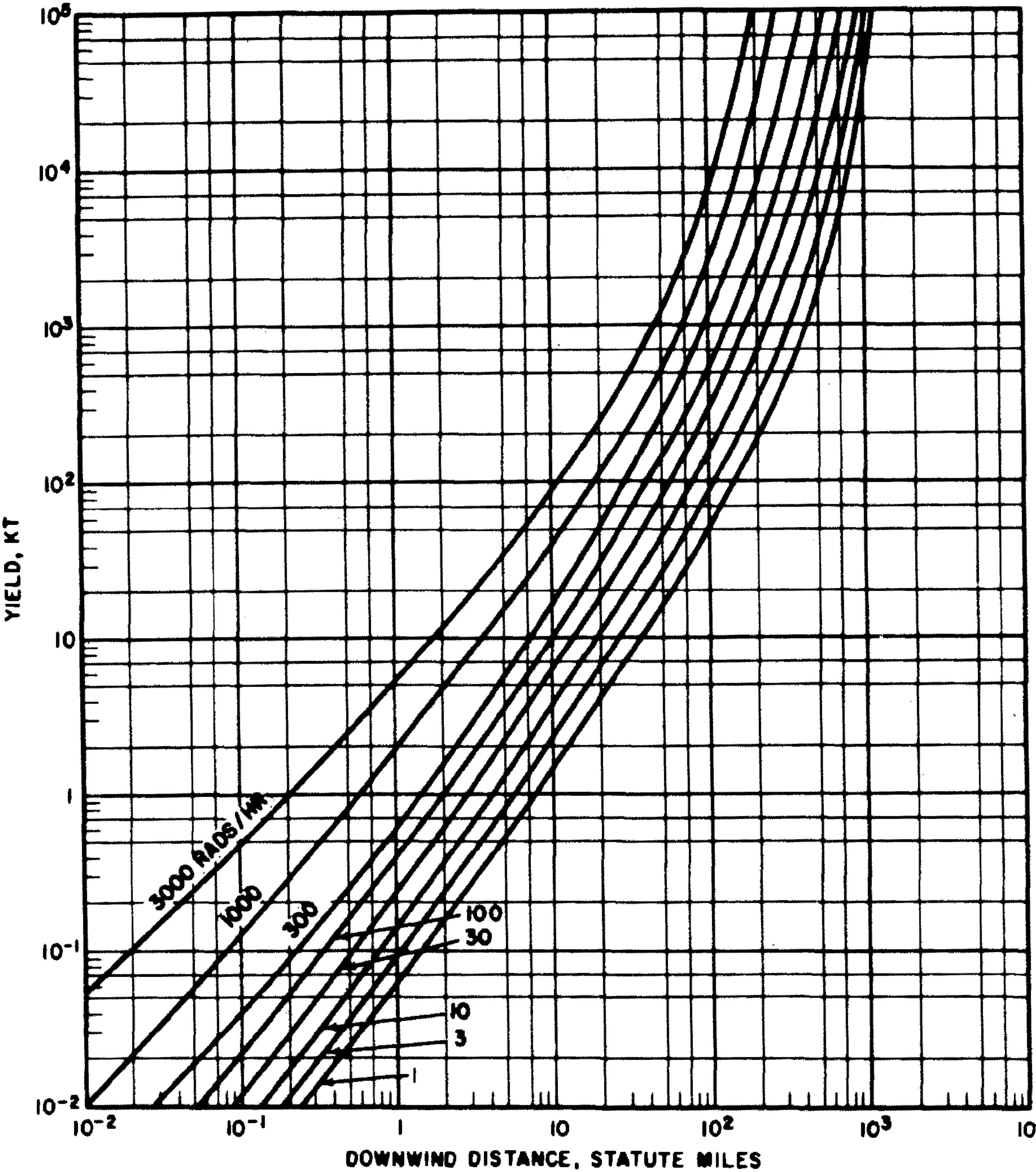


Figure 4-23. Yield vs. Downwind Distance, 10-knot Effective Wind

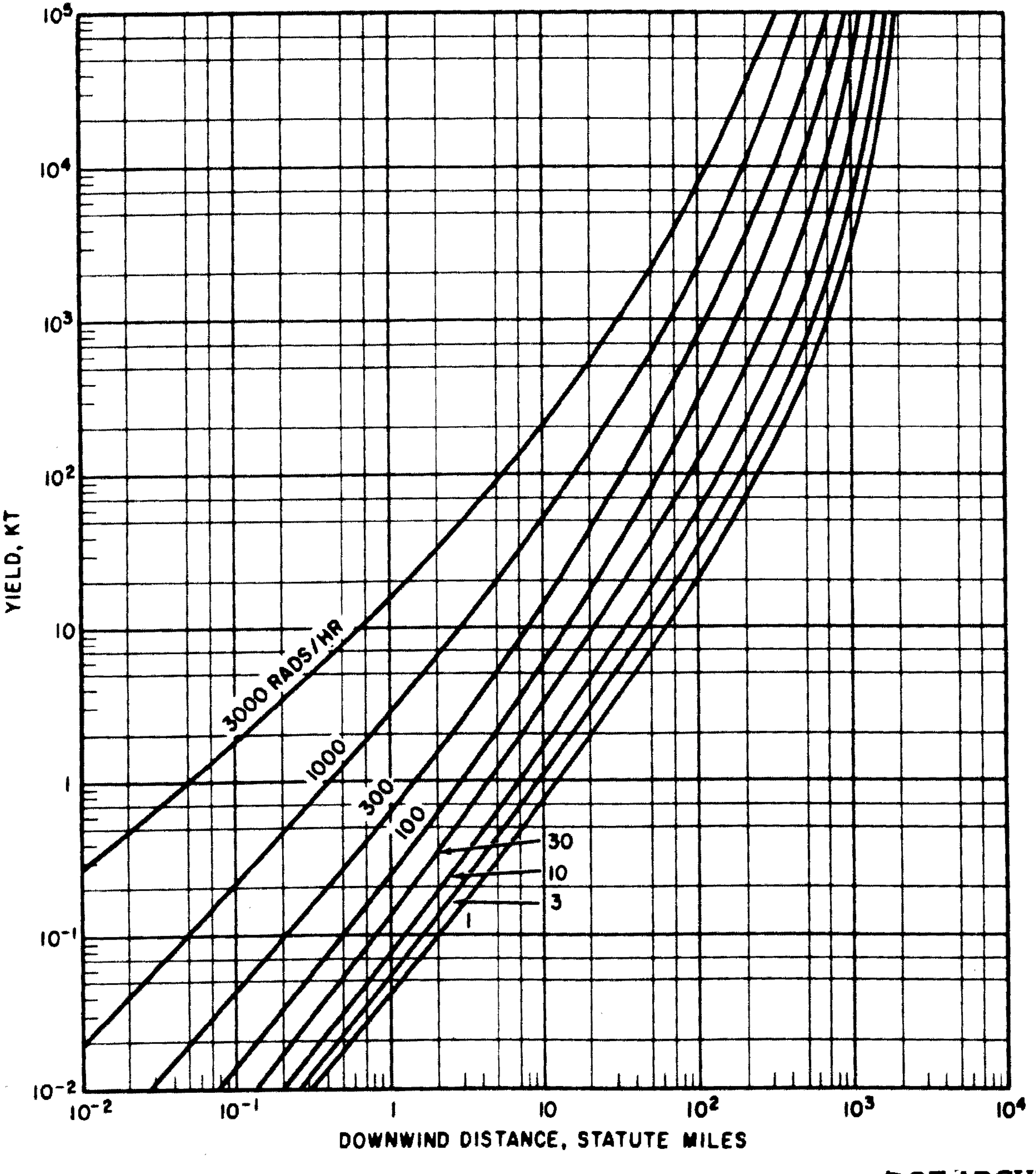


Figure 4-24. Yield vs. Downwind Distance, 20-knot Effective Wind

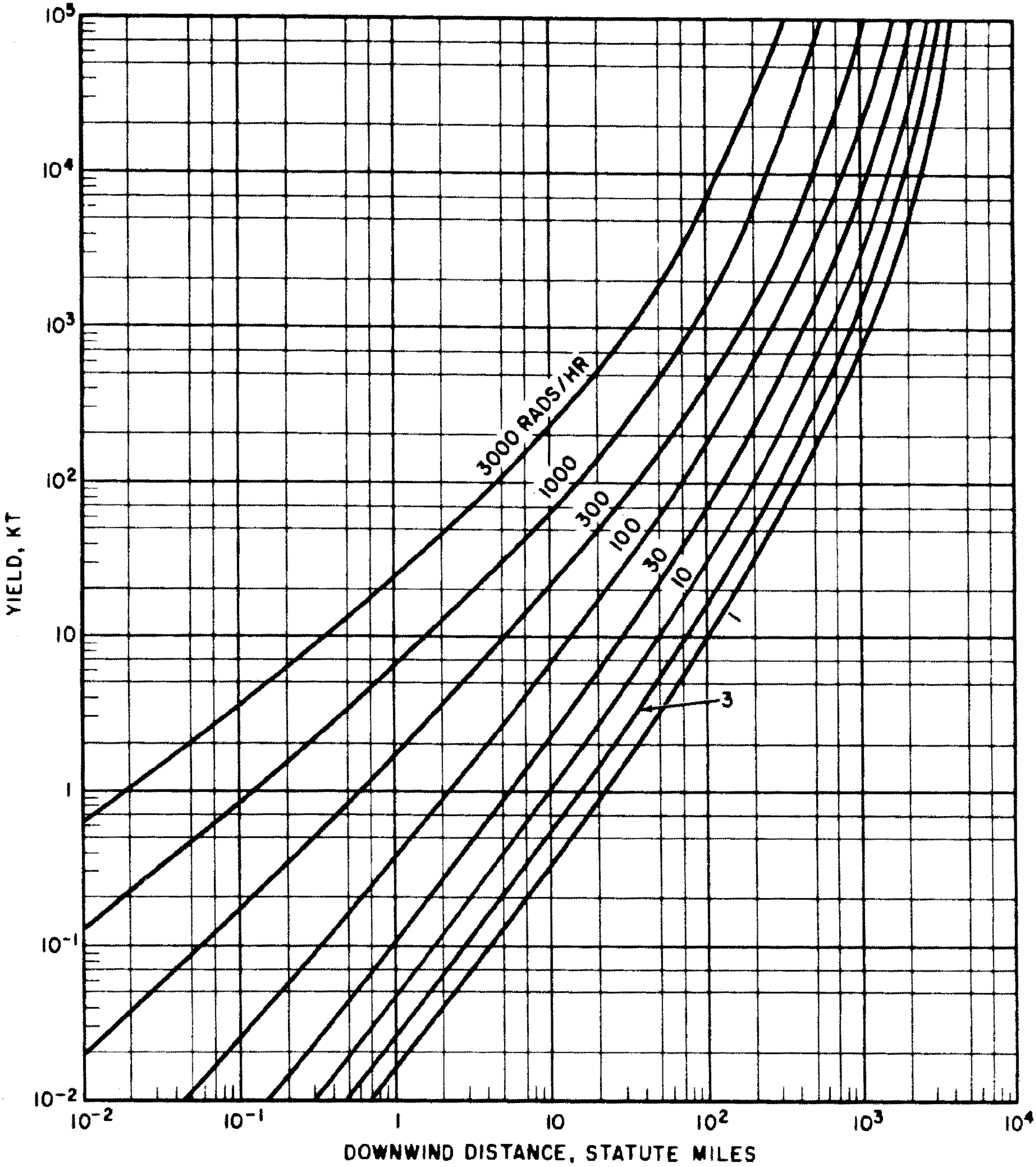


Figure 4-25. Yield vs. Downwind Distance, 40-knot Effective Wind

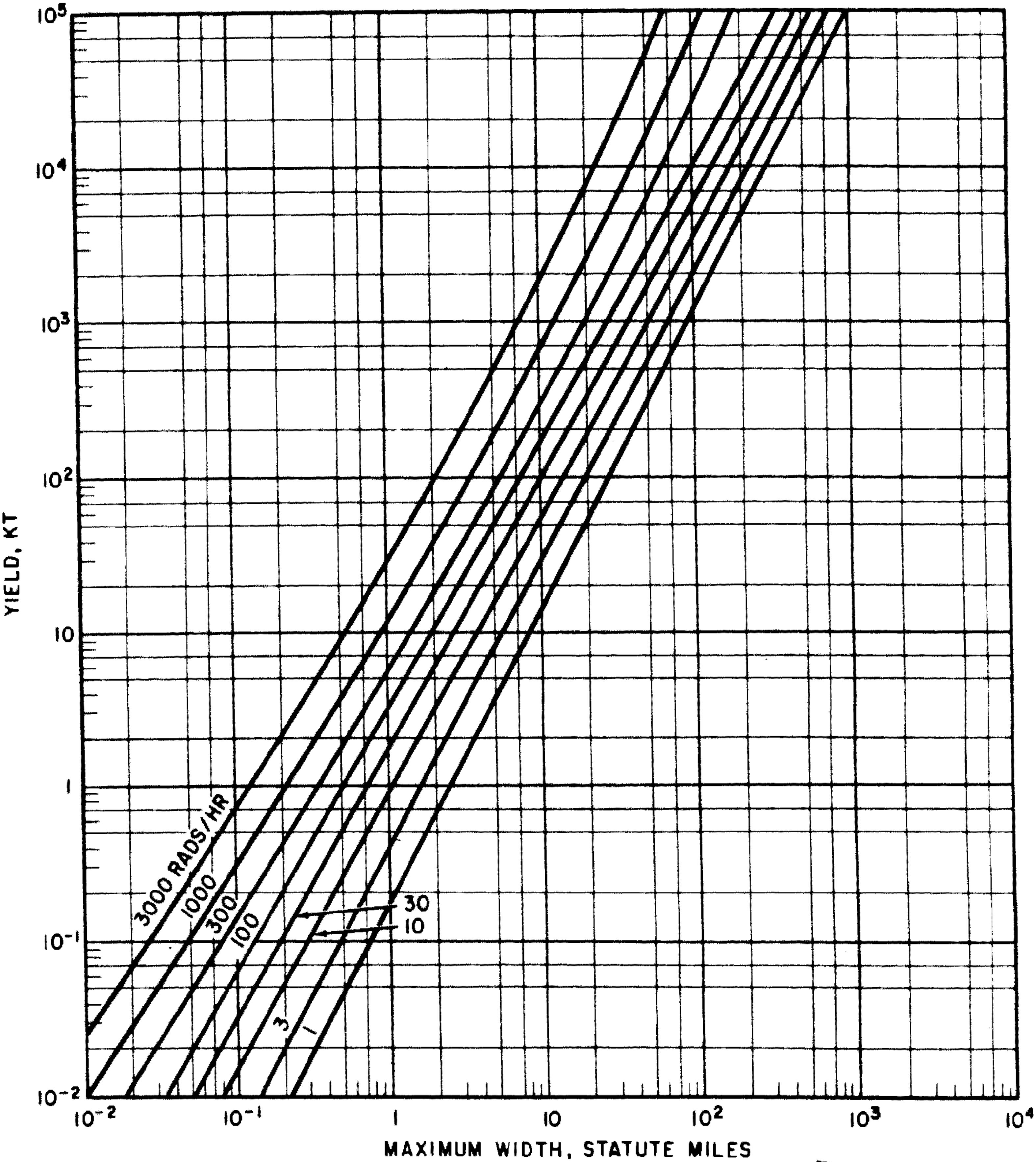


Figure 4-27. Yield vs. Maximum Width, 10-knot Effective Wind

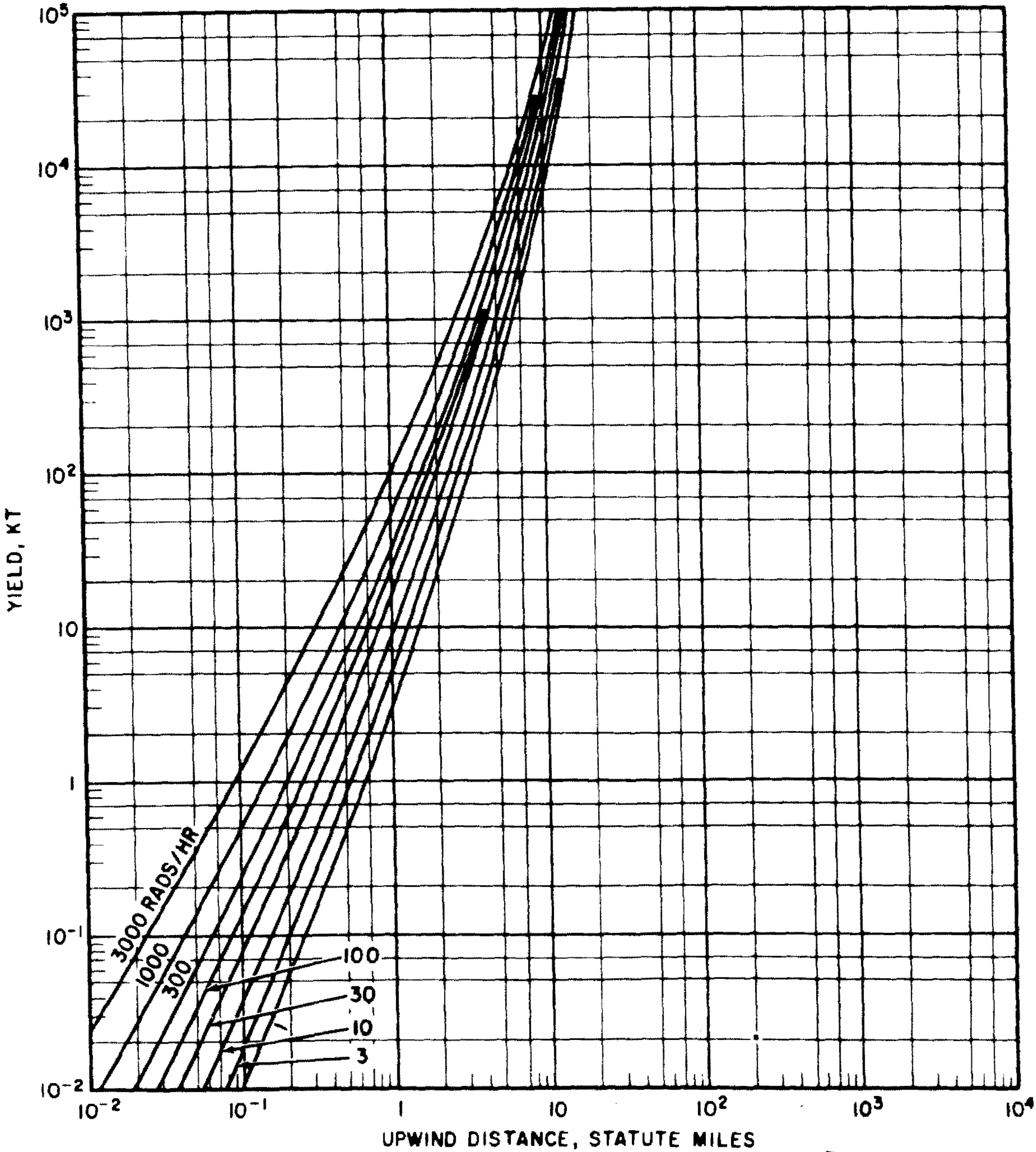


Figure 4-31. Yield vs. Upwind Distance, 10-knot Effective Wind

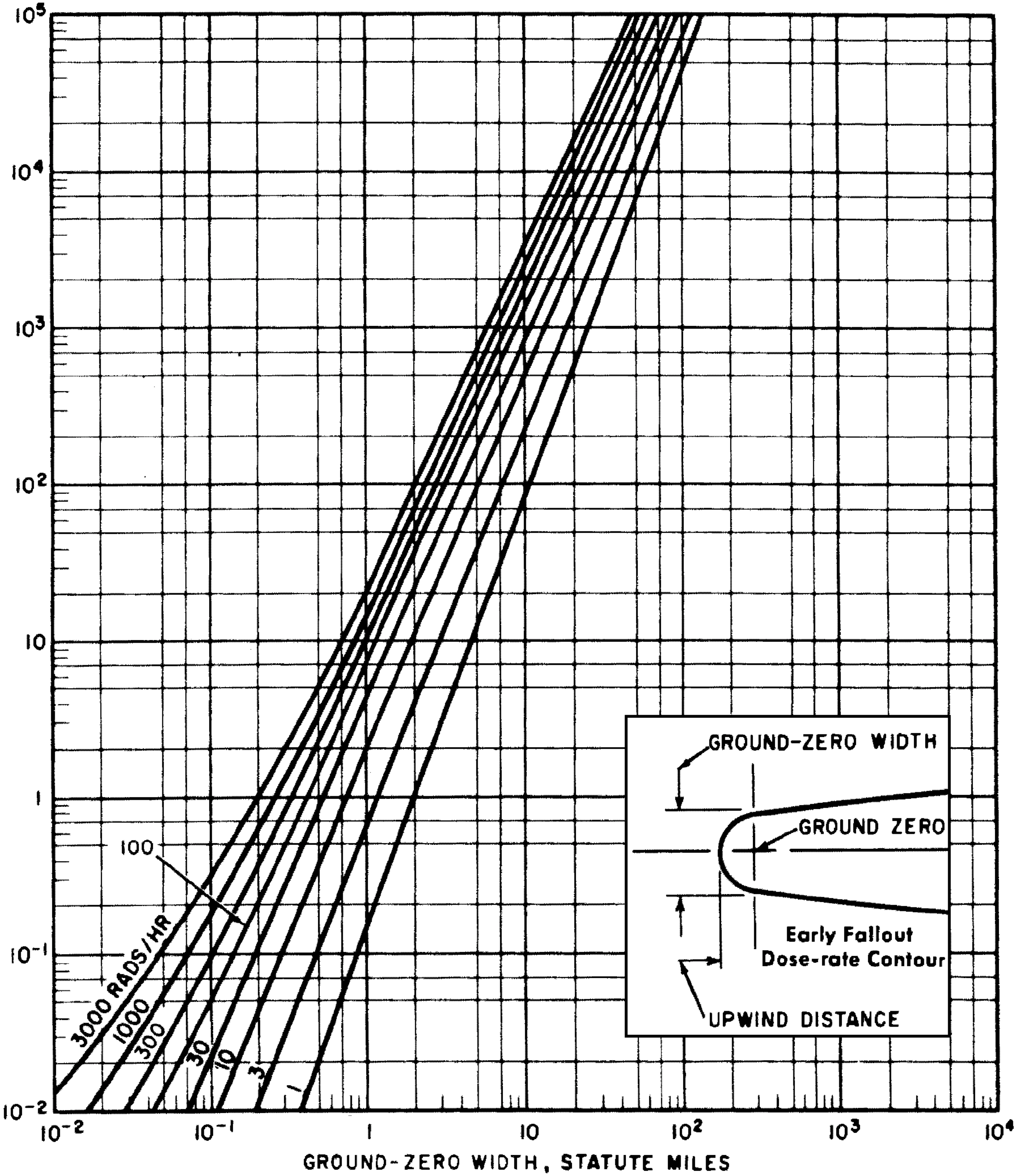


Figure 4-39. Yield vs. Ground-zero Width, 10-knot Effective Wind

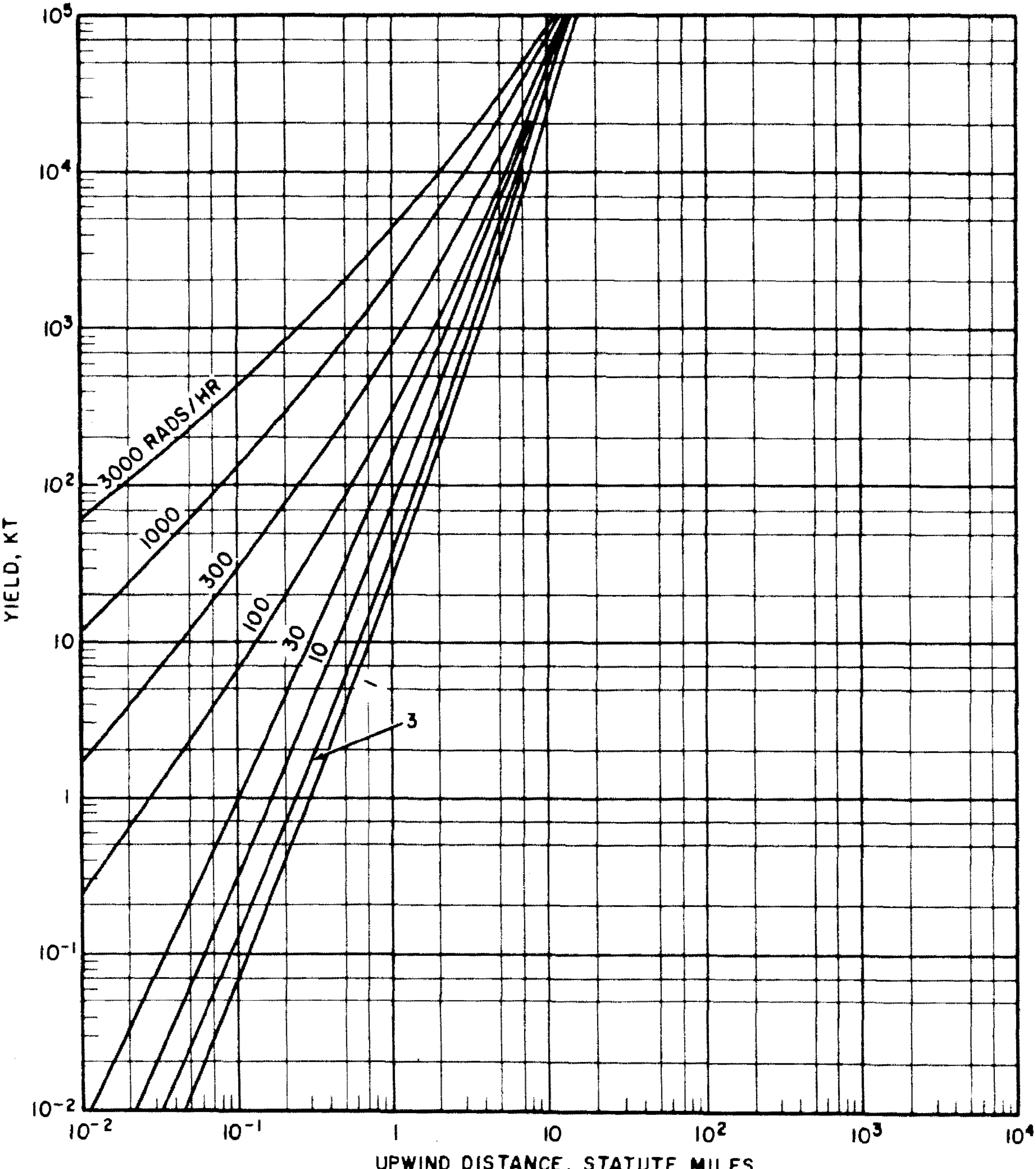


Figure 4-33. Yield vs. Upwind Distance, 40-knot Effective Wind

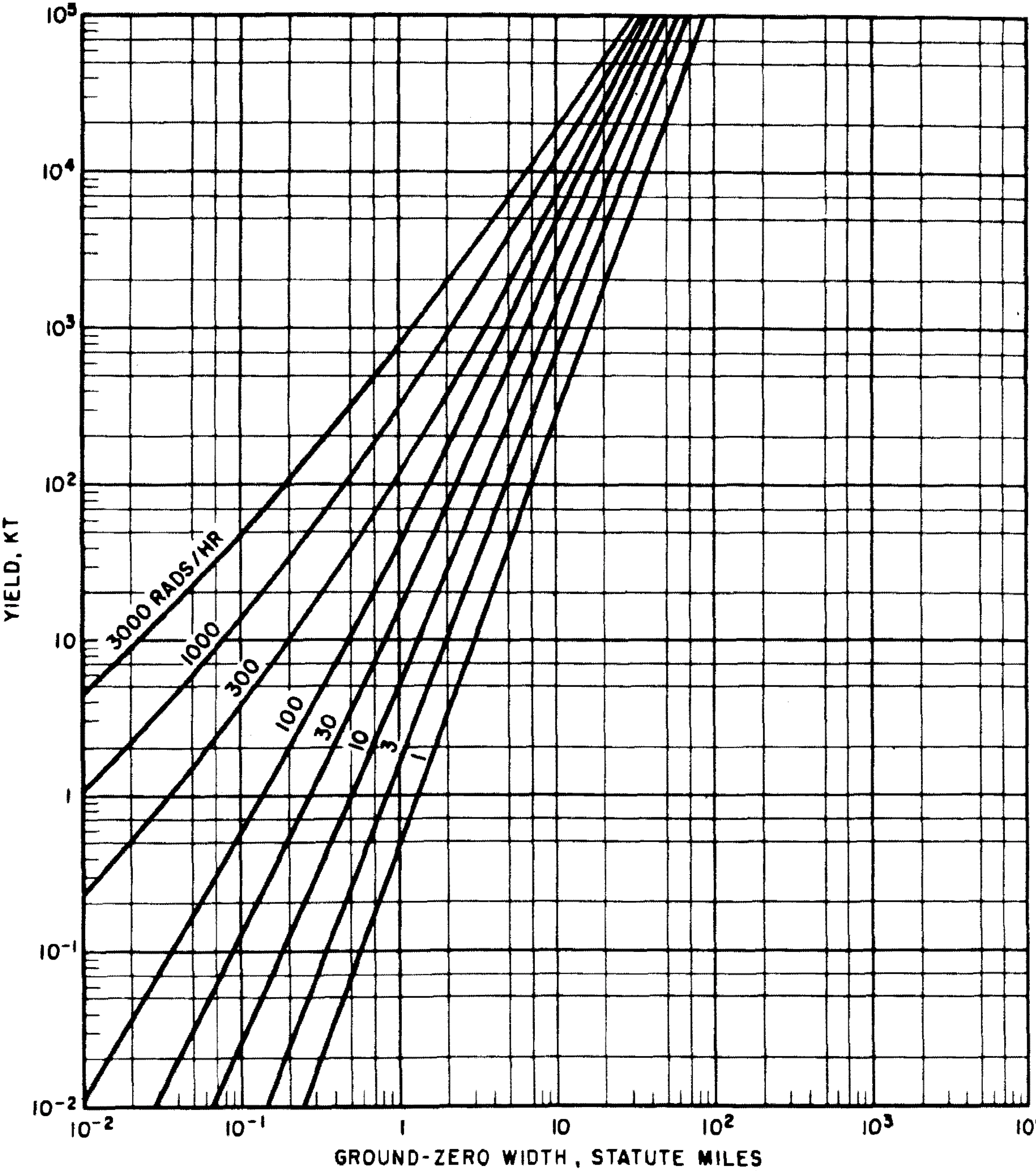


Figure 4-41. Yield vs. Ground-zero Width, 40-knot Effective Wind

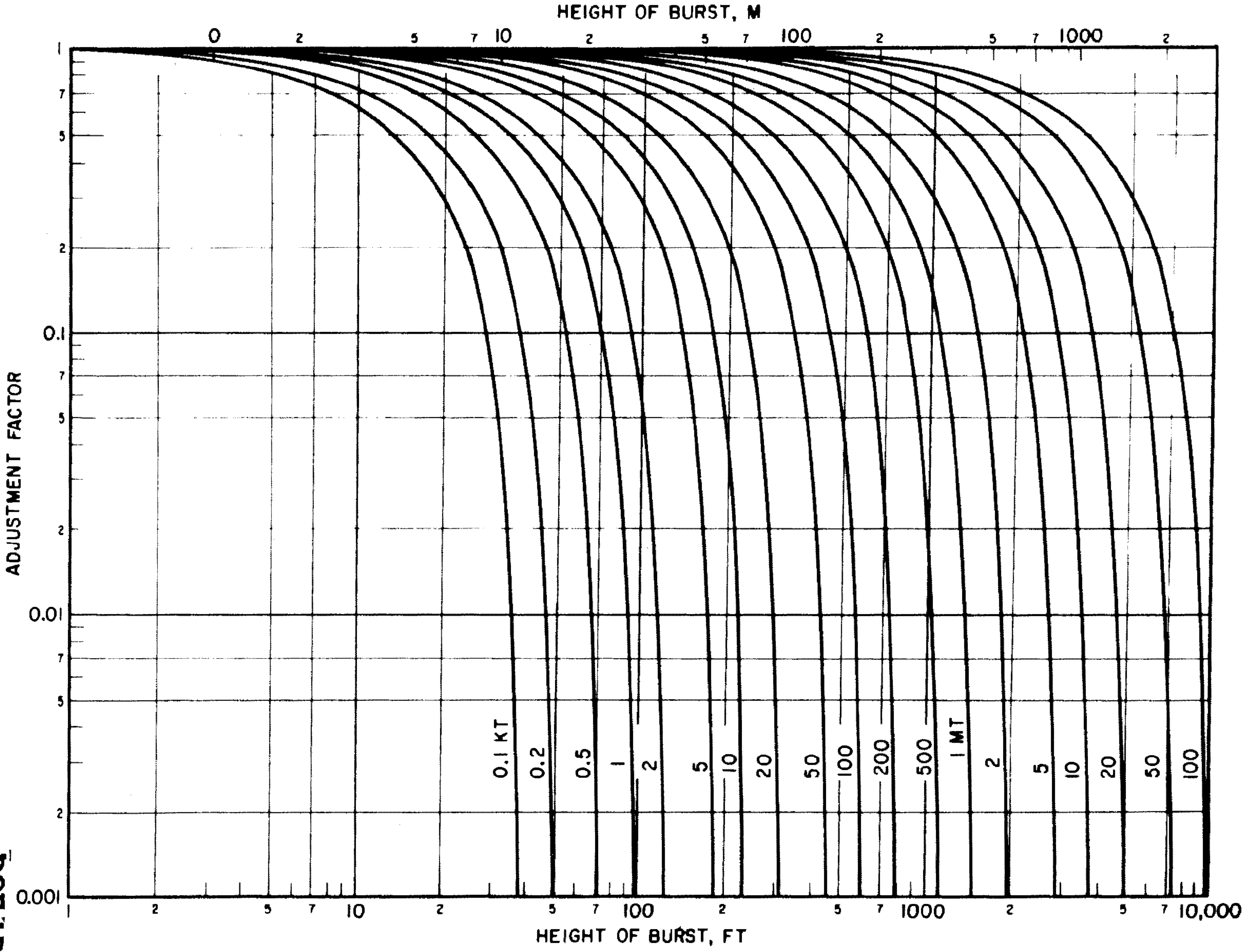


Figure 4-44. Height-of-burst Adjustment Factor for Dose-rate-contour Values Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

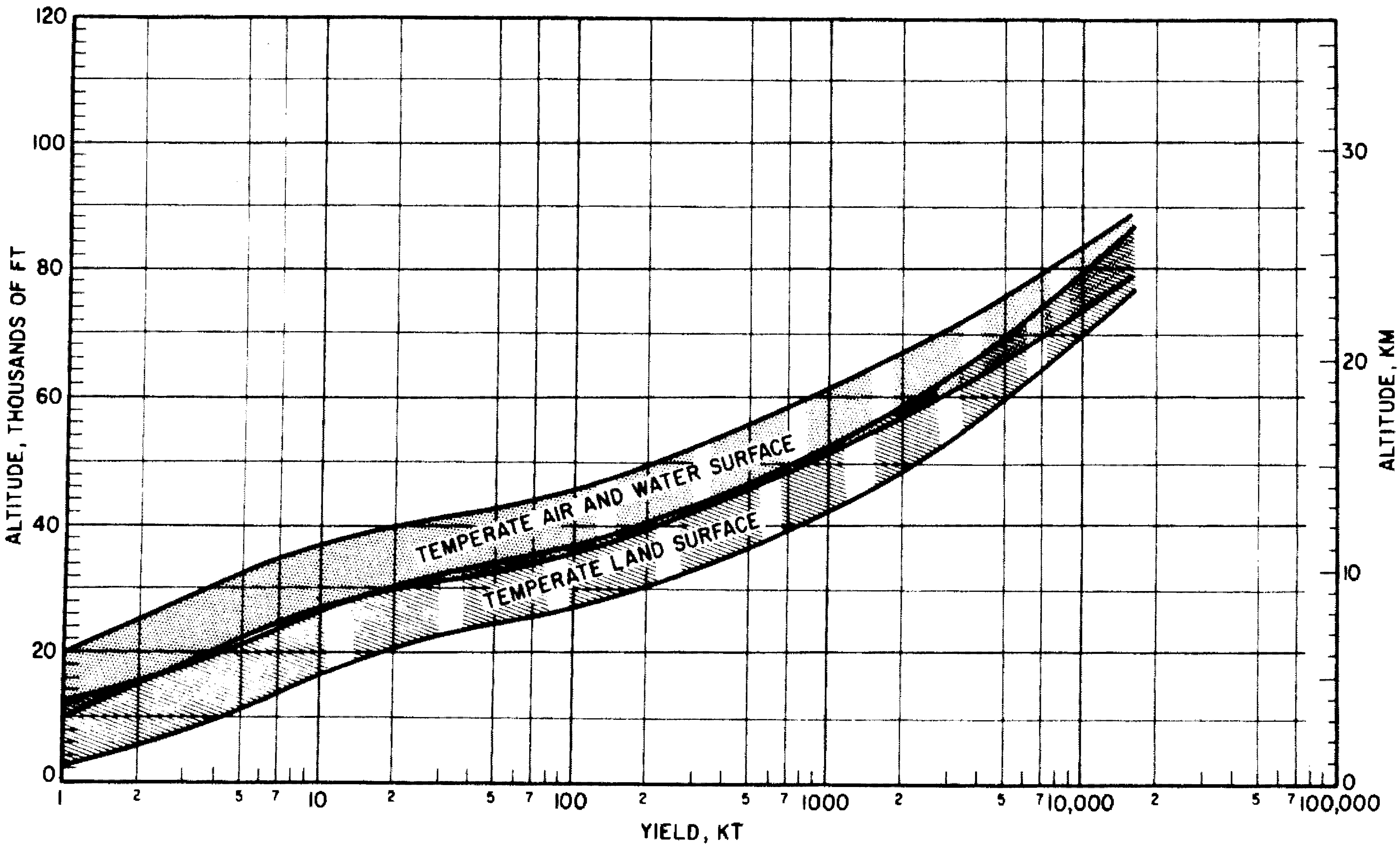


Figure 4-52. Height of Cloud Tops vs. Yield, Temperate Climates

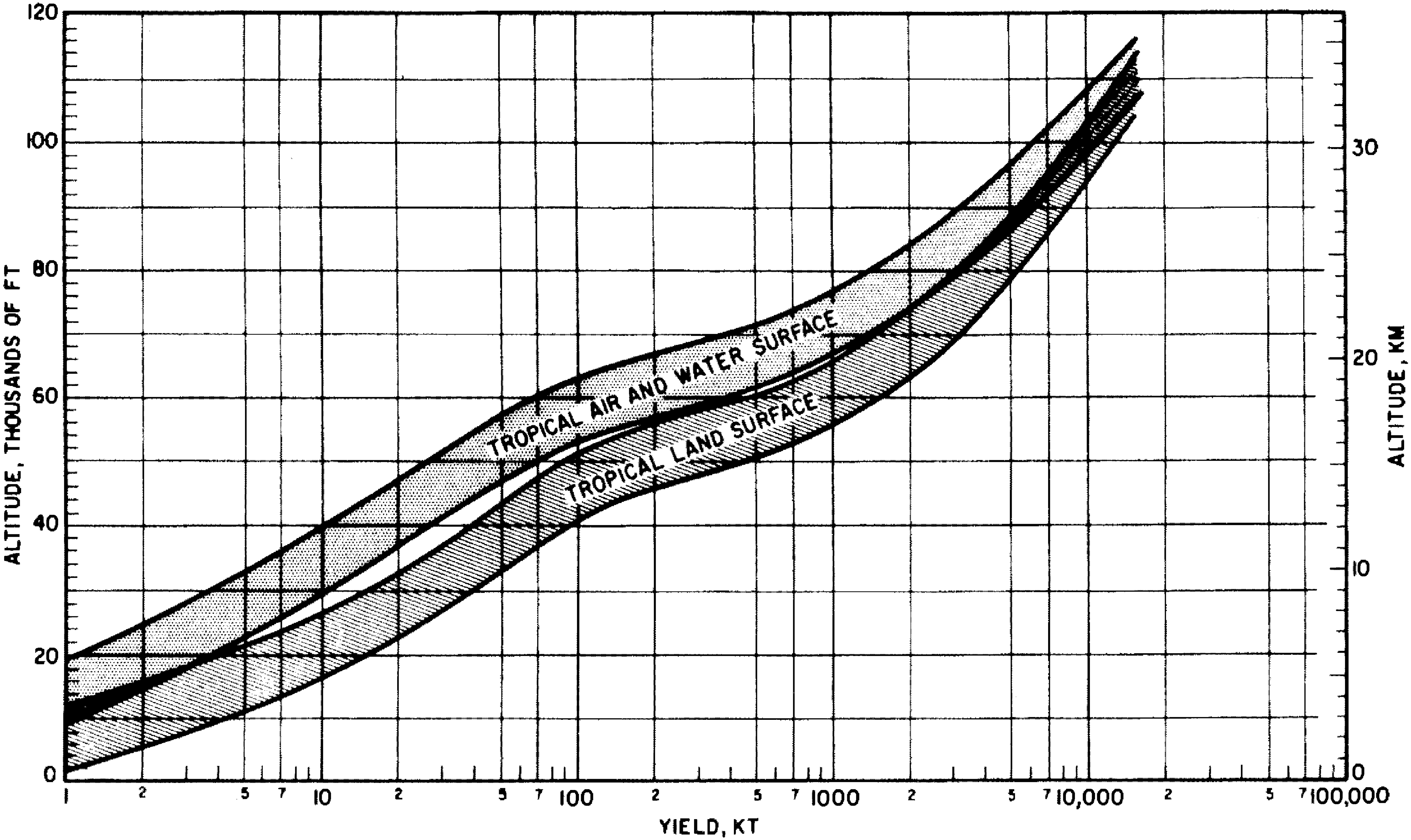


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Figure 4-53. Height of Cloud Tops vs. Yield, Tropical Climates

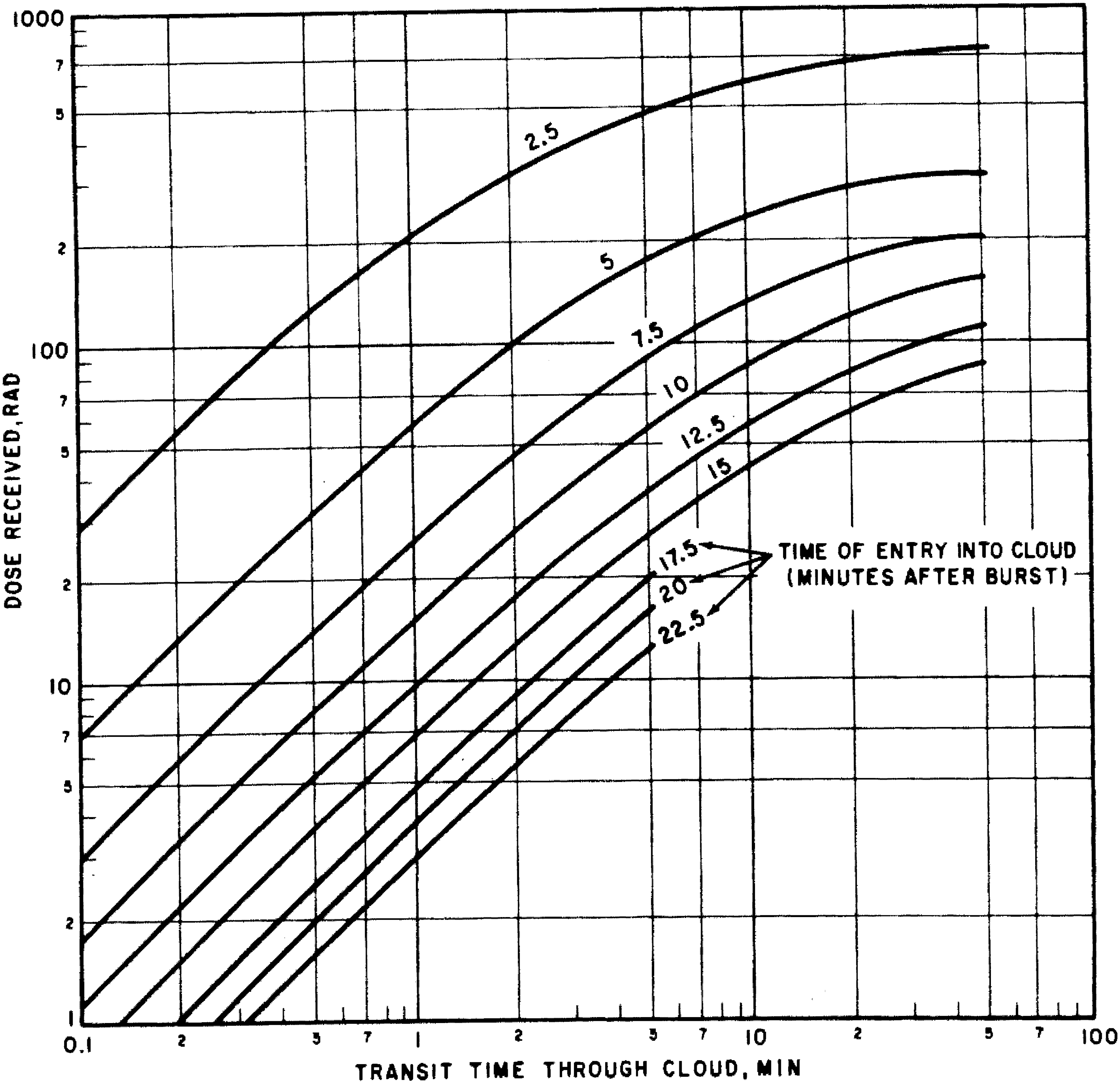

Figure 4-55. Dose Received While Flying Through a Nuclear Cloud vs. Transit Time Through Cloud

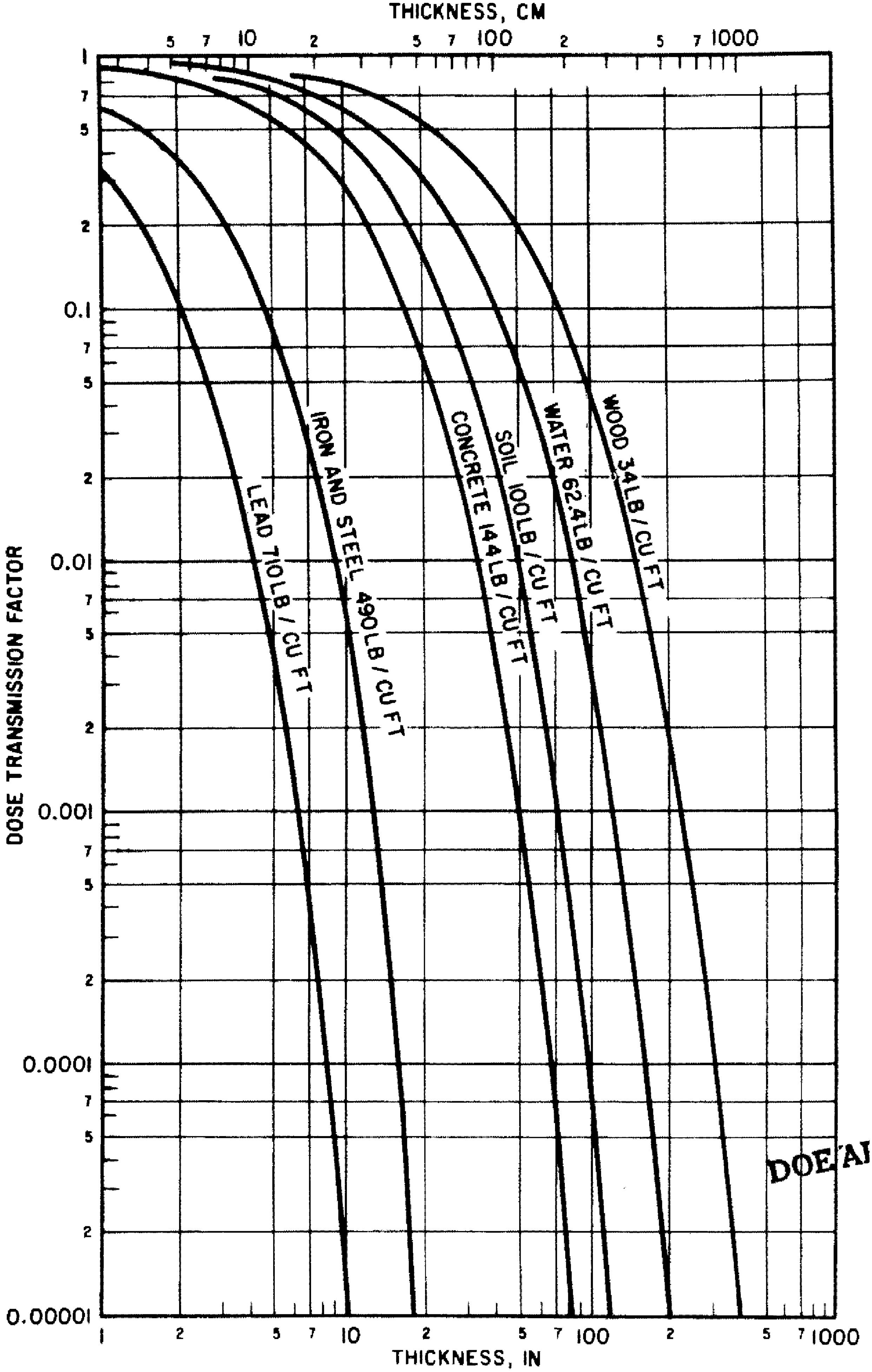

Figure 7-11. Shielding from Initial Gamma Radiation

Table 4-4 Target-burst Factors (f_{tb}) for Various Ranges of Yield and Locations of Burst and Target With Respect to Surface

Burst and Target Orientation	Air Burst Surface Target	Air Burst Air Target	Surface Burst Air Target	Surface Burst Surface Target	Sub-surface Burst Surface Target
Yield			Target-burst Factors		
Less than 400 kt	1	1.3	0.87	0.667	Obtain dose or ranges directly from figure 4-10
0.4 mt to less than 10 mt	1	1.3	1.3	1	
10 mt to 20 mt	1 (use with air-burst-surface target curves)	1.3 (use with air burst-surface target curves)	1.3 (use with surface burst-surface target curves)	1 (use with surface burst-surface target curves)	
20 mt to 40 mt	1	1.3			

Note: Extrapolation to surface burst conditions for yields greater than 20 mt and to yields above 40 mt for any burst conditions is unreliable.

Burst Location—considered an air burst when height of burst is greater than 1500 $W^{1/3}$ ft.

Target Position—considered an air target when target location is greater than 300 ft above the surface.

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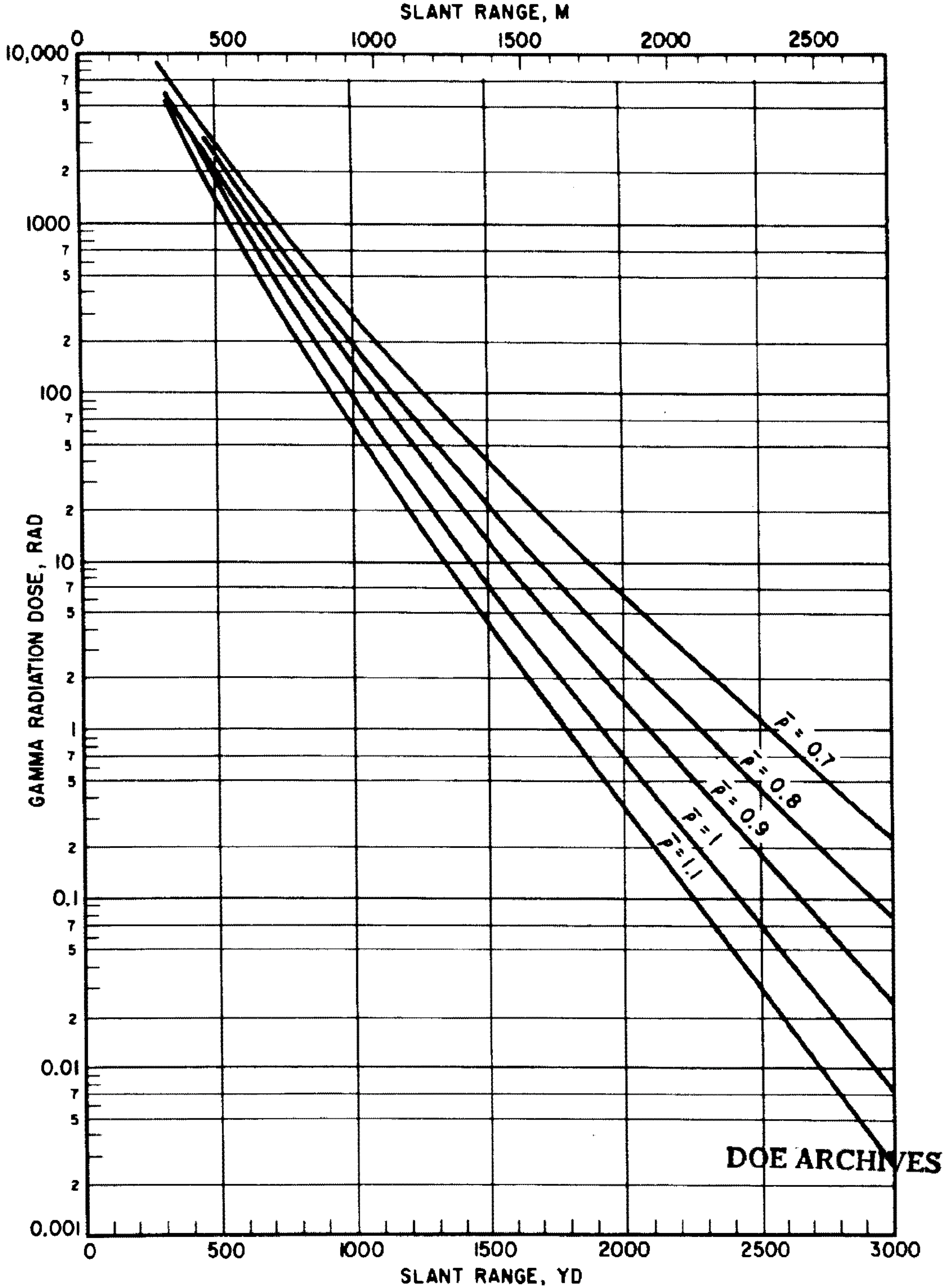

Figure 4-10. Initial Gamma Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-kt Underground Burst, Surface Target Depth 17 ft

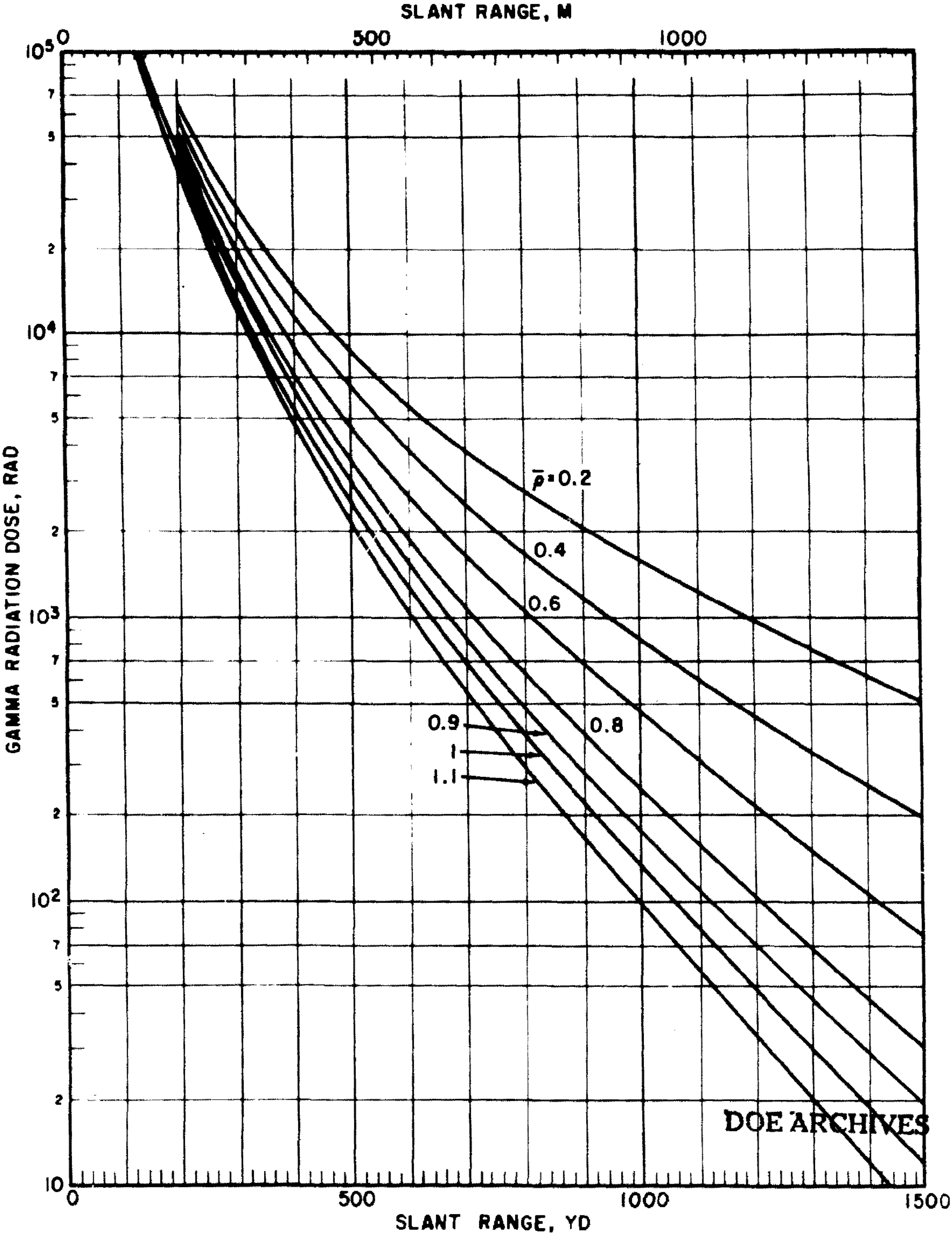

Figure 4-9(A). Initial Gamma Radiation Dose vs. Slant Range (to 1500 yd) for Various Average Relative Air Densities, 1-kt Air Burst-Surface Target

Weapon design strongly influences neutron radiation. Figures 4-17 to 4-20 are given as representative curves applicable to four general weapon categories based upon expected neutron output. Figure 4-17 applies to sub-kiloton yields and the dose is given in units of rads/ton. Figures 4-18 and 4-19 apply to average and high-flux kiloton fission weapons respectively, and the units are in rads/kt. Figure 4-20 applies to fusion weapons and the dose is given in units of rads/mt. From these curves the slant range can be determined at which a weapon of given yield will produce a specified dose; conversely, the yield required to produce a given dose at a desired range can also be found.

Several other factors will influence the dose expected at a given target location. If either the target or the burst is raised above the surface the dose can be expected to increase by approximately 50 percent. If the target is located on the water the dose can be expected to be reduced. Figures 4-17 to 4-19, curves for sub-kiloton and kiloton fission weapons, apply directly to the dose received by a land surface target from a low air burst (fireball does not touch the ground). Figure 4-20 applies directly to the dose received by a land surface target from a surface burst.

Table 4-5 Adjustment Factors for Varying Given Conditions

Condition	Factor
Target location on water surface	0.85
Target location airborne	1.5
Changing burst location from air to surface	0.67
Changing burst location from surface to air	1.5

Scaling. At a given range and relative air density, the neutron dose is proportional to weapon yield. For relative air density, see appendix B.

Example 1.

Given: A high flux 50-kt burst at 2000 ft above a water surface where the average air density between the point of burst and the target location is 0.8.

Find: The maximum neutron dose on the surface of the water at a slant range of 2200 yd.

Solution: From figure 4-19 for $\overline{\rho} = 0.8$ the dose for 1 kt at 2200 yd is 2 rads. The correction factor for the target being on water rather than on land is 0.85.

Answer: Therefore the maximum dose on the surface of the water for 50 kt at 2200-yd slant range and $\overline{\rho} = 0.8$ is $2 \times 50 \times 0.85 = 85$ rads.

Example 2.

Given: A sub-kiloton weapon burst on the ground where the relative air density is 0.9.

Find: The yield required to deliver a neutron dose of 450 rads to the outside of a bunker 500 yd from ground zero.

Solution: From the information given, figure 4-17 (sub-kiloton fission) must be used. Because the given conditions for figure 4-17 are air burst-surface target, the adjustment factor "changing burst location from air to surface—0.67" (see table 4-5) must be used to correct for a surface burst.

Answer: From figure 4-17 for $\overline{\rho} = 0.9$ read 7.2 rads/ton at 500 yd, air burst-surface target.

$$7.2 \text{ rads/ton} \times 0.67 \text{ (adjustment factor)} = 4.82 \text{ rads/ton delivered to target}$$

$$\frac{450 \text{ rads total}}{4.82 \text{ rads/ton}} = 92 \text{ tons}$$

Reliability. Depending upon weapon design, it is estimated that the dose values given in figures 4-17 through 4-20 may be low by as much as a factor of 2 for certain very high flux designs and high by as much as a factor of 5 for some older weapon designs.

Related Material. See paragraph 4-6.

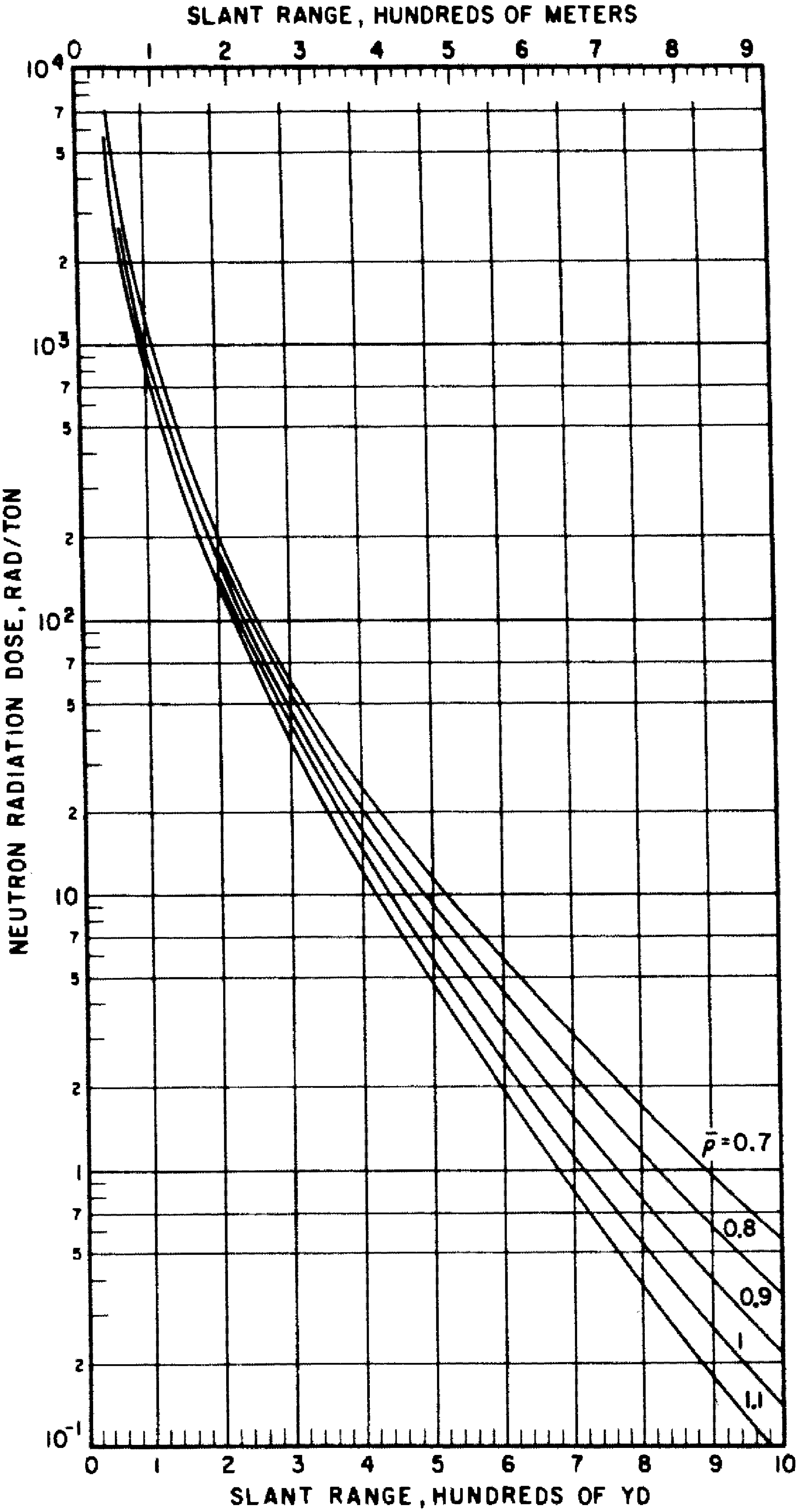

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Figure 4-17. Neutron Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-ton (Sub-kiliton Fission) Air Burst-Surface Target

Table 4-1 Chemical Composition of Illustrative Soils

Element	Type I (Liberia, Africa)	Type II (Nevada desert)	Type III (lava, clay, Hawaii)	Type IV (beach, sand, Pensacola, Florida)
	Percentage of soil type (by weight)			
Sodium	—	1.30	0.16	0.001
Manganese	0.008	0.04	2.94	—
Aluminum	7.89	6.90	18.79	0.006
Iron	3.75	2.20	10.64	0.005
Silicon	33.10	32.00	10.23	46.65
Titanium	0.39	0.27	1.26	0.004
Calcium	0.08	2.40	0.45	—
Potassium	—	2.70	0.88	—
Hydrogen	0.39	0.70	0.94	0.001
Boron	—	—	—	0.001
Nitrogen	0.065	—	0.26	—
Sulfur	0.07	0.03	0.26	—
Magnesium	0.05	0.60	0.34	—
Chromium	—	—	0.04	—
Phosphorous	0.008	0.04	0.13	—
Carbon	3.87	—	9.36	—
Oxygen	50.33	50.82	43.32	53.332

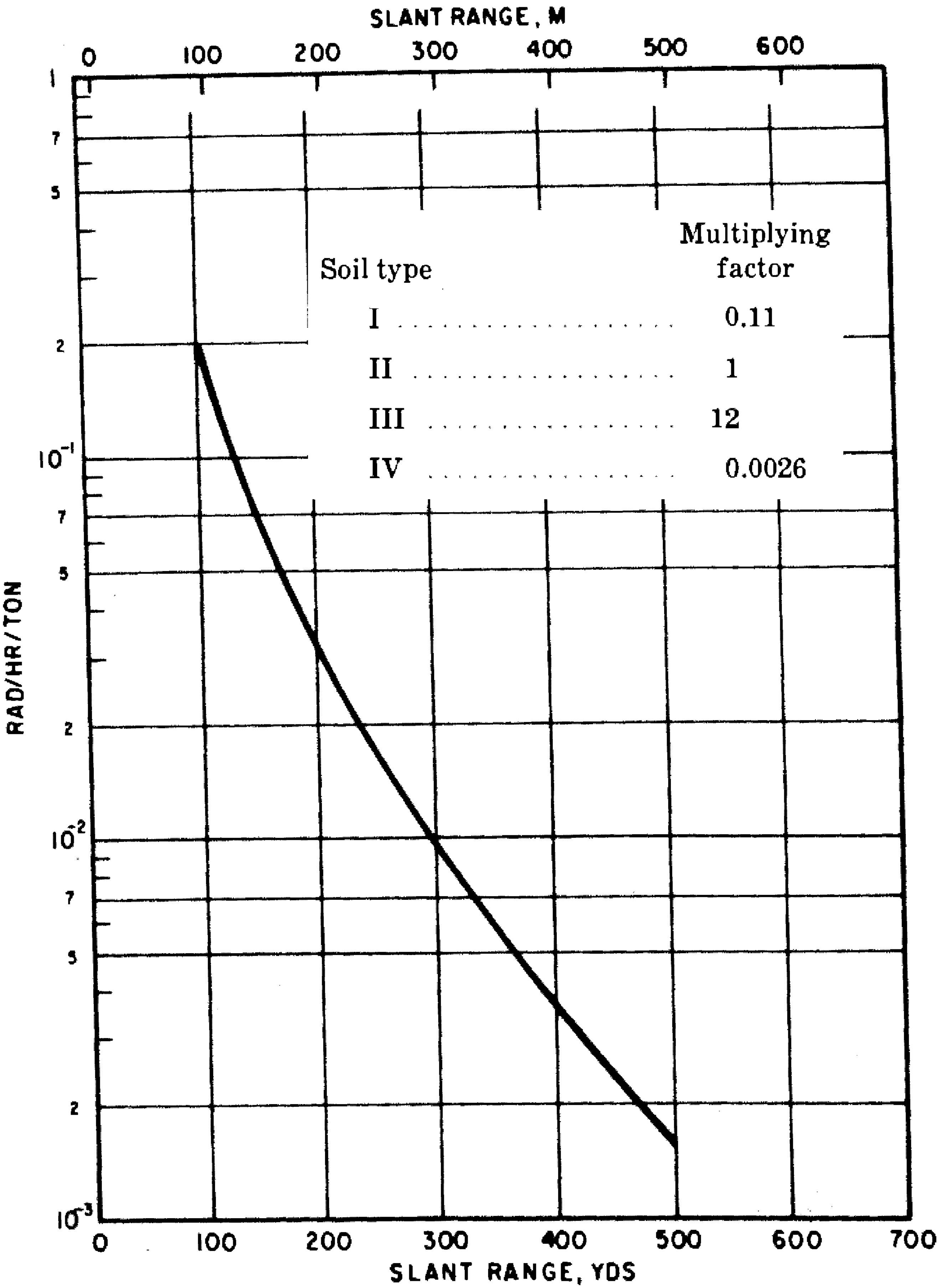

Figure 4-56. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Sub-kiloton Fission Weapons per Ton

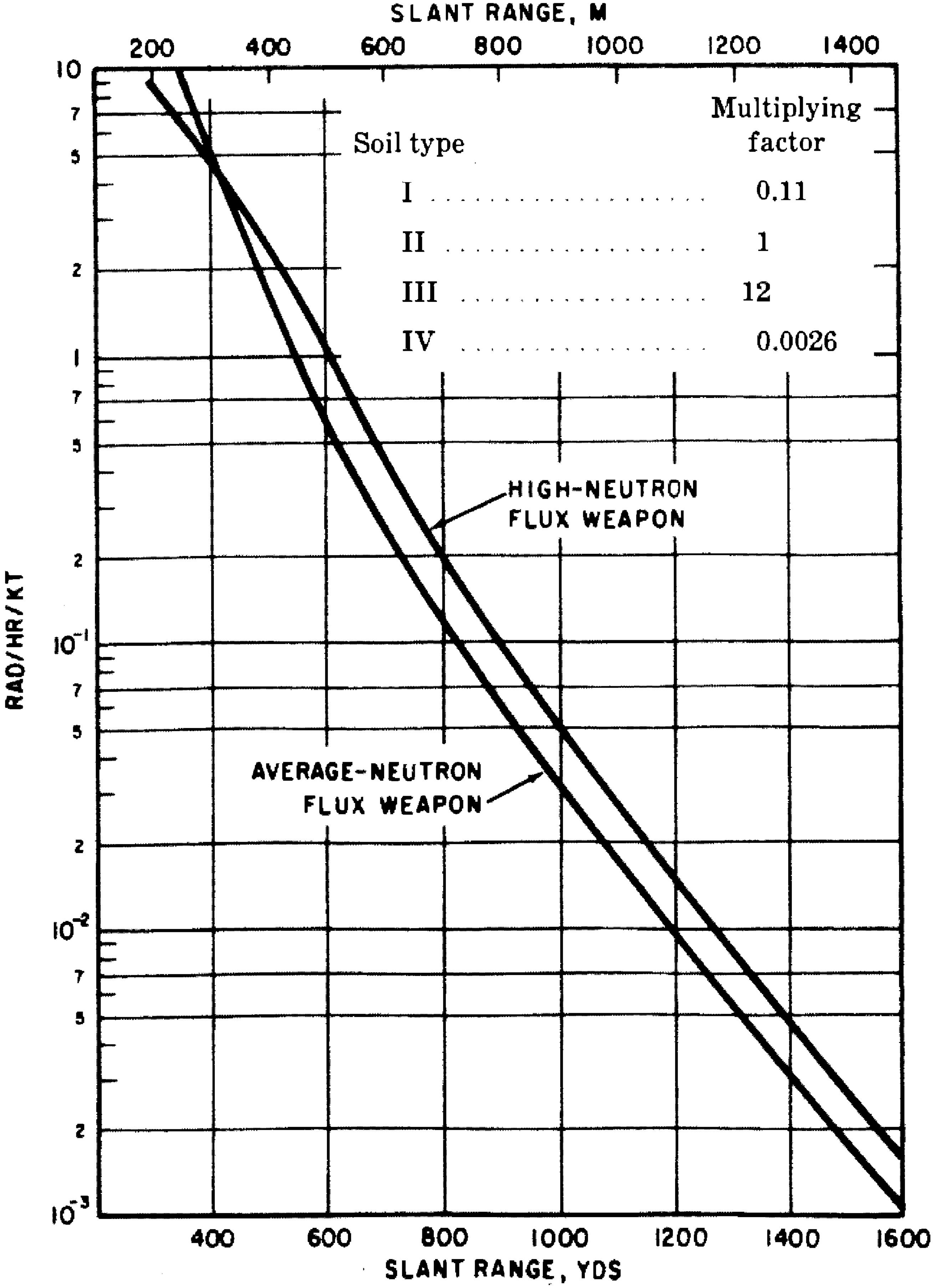

Figure 4-57. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Fission Weapons per kt

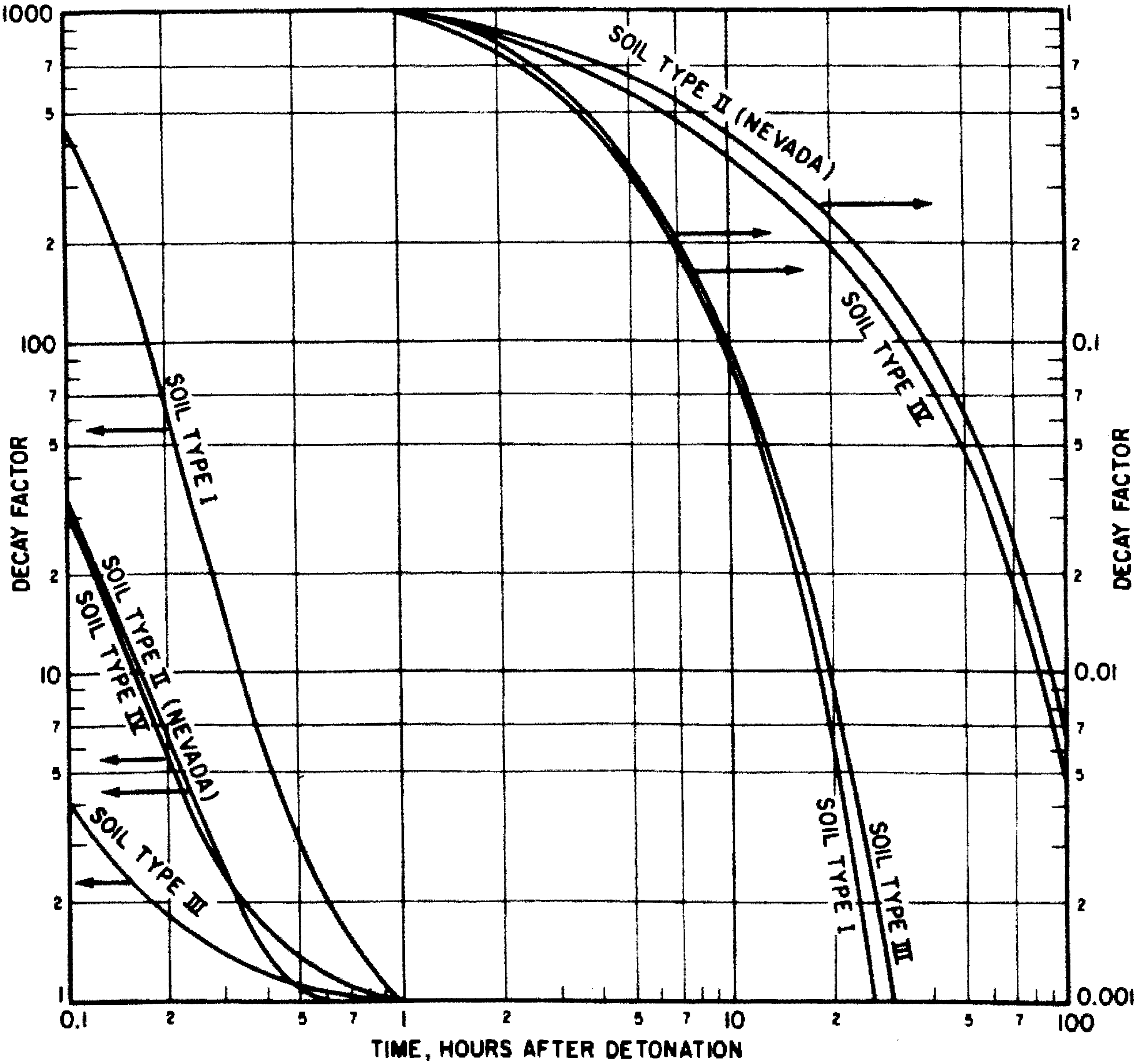

Figure 4-59. Decay Factors for Neutron-induced Gamma Activity

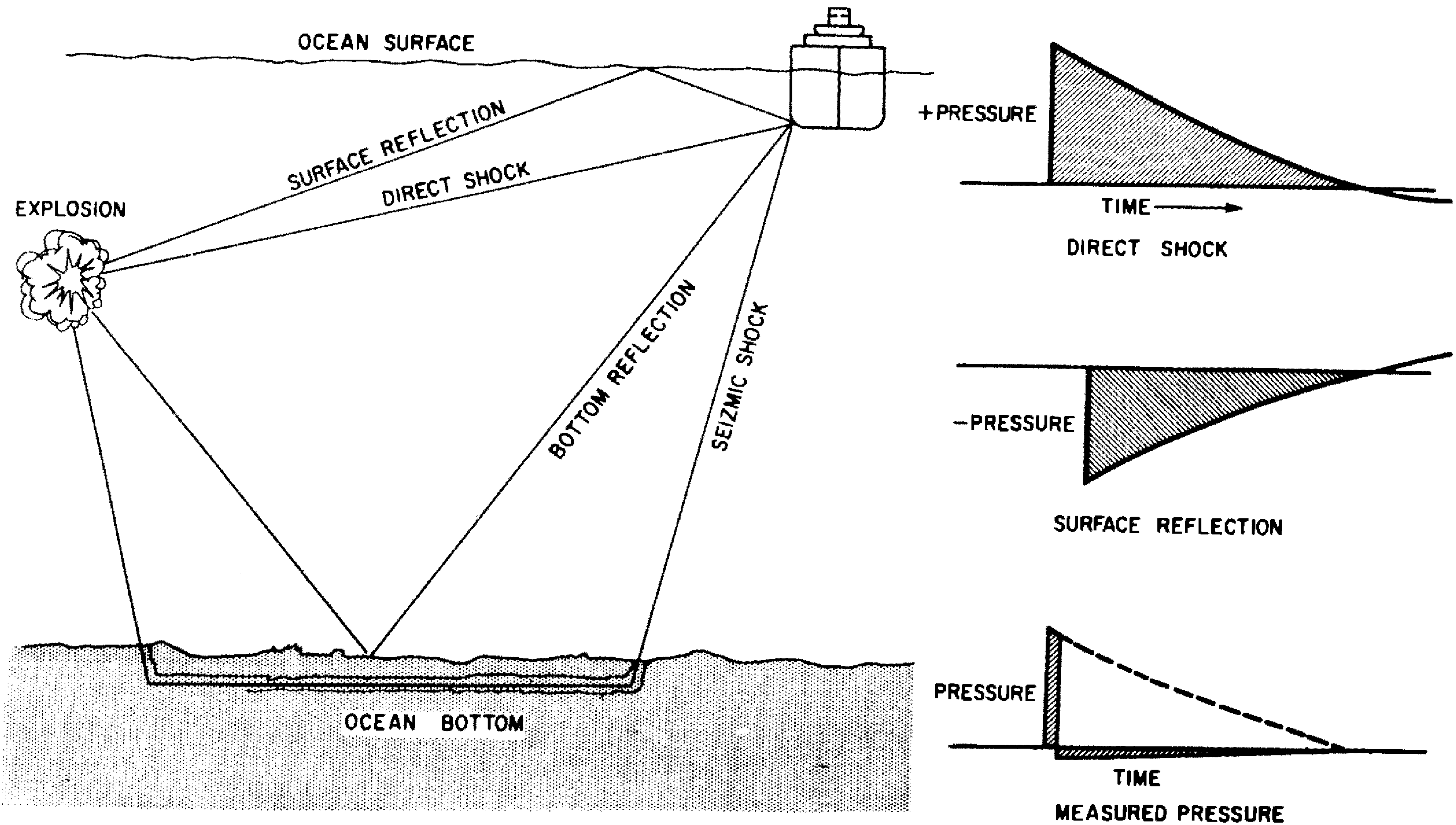

Figure 6-2. Direct and Reffected Shock Waves from an Underwater Burst

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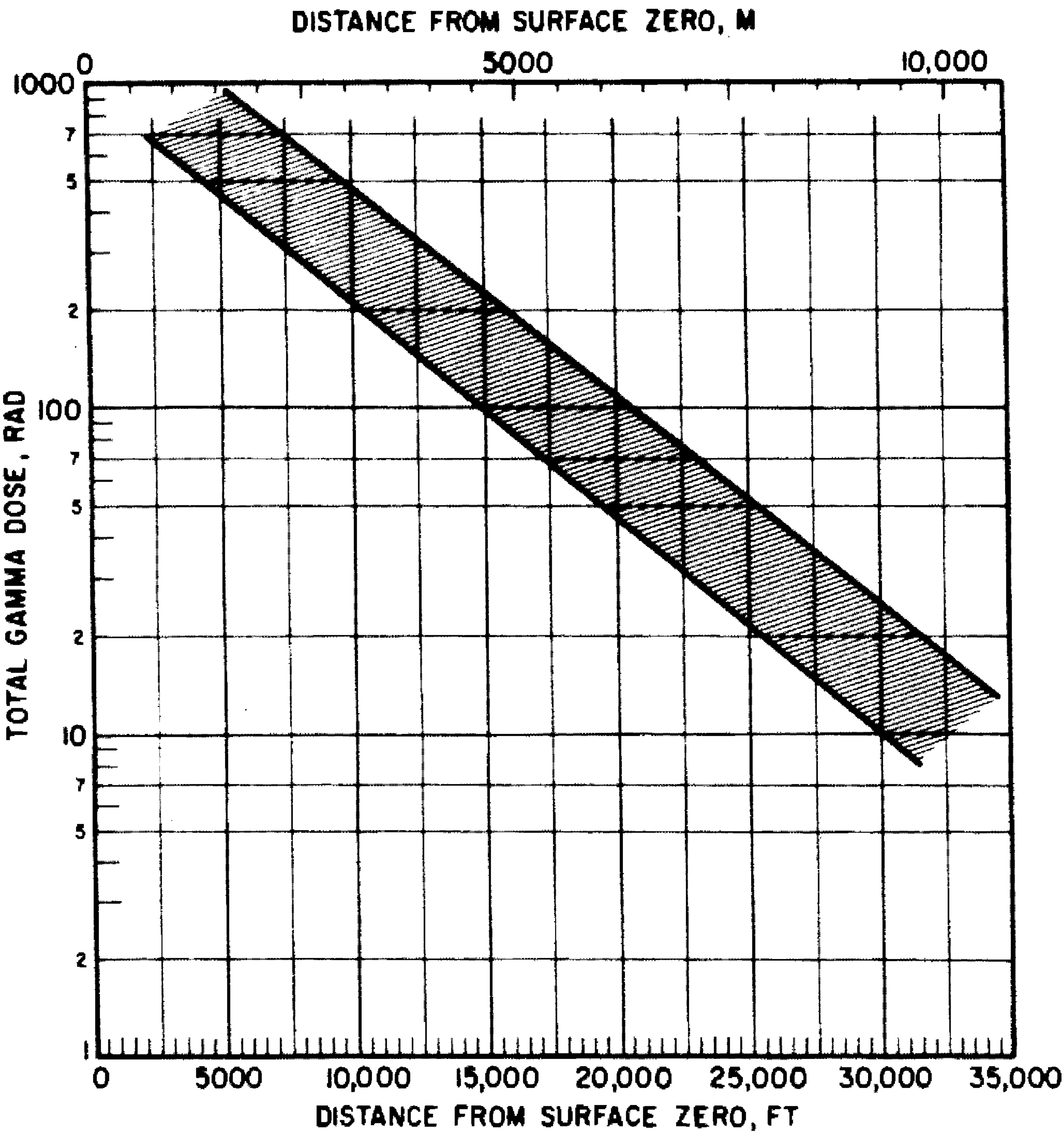


Figure 4-49. Total Dose at the Surface Downwind from a 10-kt Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

some fission products are lost along the path of migration to the surrounding water.

4-28 Fractionation. The radioactive material carried by the base surge, in most cases, fractionates in favor of those fission products having rare-gas ancestors. This probably results from scavenging of the more-refractory fission products by the early subsiding masses of water from the columns of plumes, thereby returning them to the ocean in the immediate vicinity of surface zero.

4-29 Time-space History of the Above-surface Radiation Fields. For all types of underwater explosions, the major source of radiation, to the observer on the surface, is probably the base surge, which can be extremely dangerous to any station it engulfs. Although the total quantity of fission products within the base surge amounts to some 10 to 30 percent of that initially formed, the specific activity is very high because of the early age of the radioactivity. It should be emphasized that *very close* to subsiding columns or plumes, the base surge deposits significant amounts of radioactive material on the surface causing a temporary radiological hazard. The phenomenon is almost entirely transient in nature, similar to being engulfed by a heavy fog.

Evidence to date suggests some distinct differences in the geometry of the base surge depending on whether the explosion is shallow (columns) or deep (plumes). In either case the resulting surge expands radially at a high velocity, and takes the form of a toroid for shallow explosions and is more like concentric multiple toroids for deep explosions. These differences in geometry have two effects on the time-space history of the radiation: as the single toroid passes over a station, the dose rate and dose are delivered in two increments (the forward and rear actions of the ring), as seen in figure 4-6; where concentric multiple toroids are formed, as is the case for the deep explosion, the radiation is delivered over one broad continuous increment, as shown in figure 4-7. The time of passage depends on the maximum extent of the surge periphery, the location of the observer, and the wind speed.

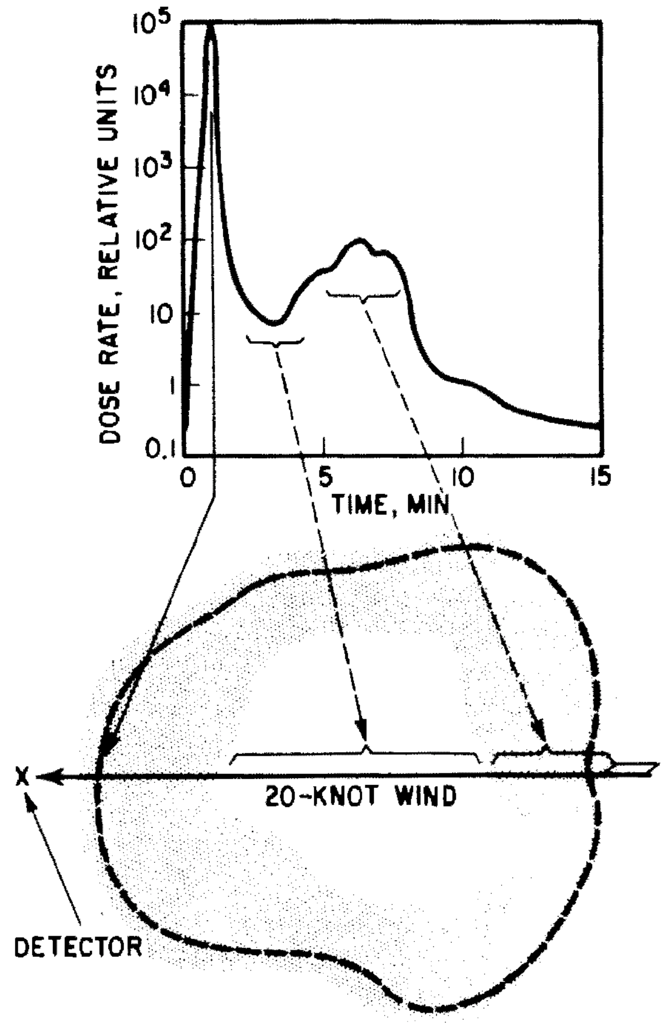


Figure 4-6. Dose Rate vs. Time for a Shallow Underwater Burst

4-30 Water Surface Shot. Nominal-yield bursts on the surface of deep water will resemble the very shallow detonation with the addition of some prompt gamma and neutron activated nitrogen in the atmosphere. For high yields such as a megaton surface burst over shallow water (less than 200 ft deep) the above-surface effects will be similar to those of a land detonation, with the cloud rising to greater heights. Probably, no base surge will develop, but the fallout likely will be different from a land surface burst, and the area of militarily significant fallout will probably be smaller. If the yield is large enough for the cloud to reach the tropopause, the cloud upon reaching this level will rise more slowly and increase in lateral dimensions more rapidly as though flattening out against a ceiling. After reaching maximum altitude, the diameter slowly increases as the cloud drifts downwind. Figure

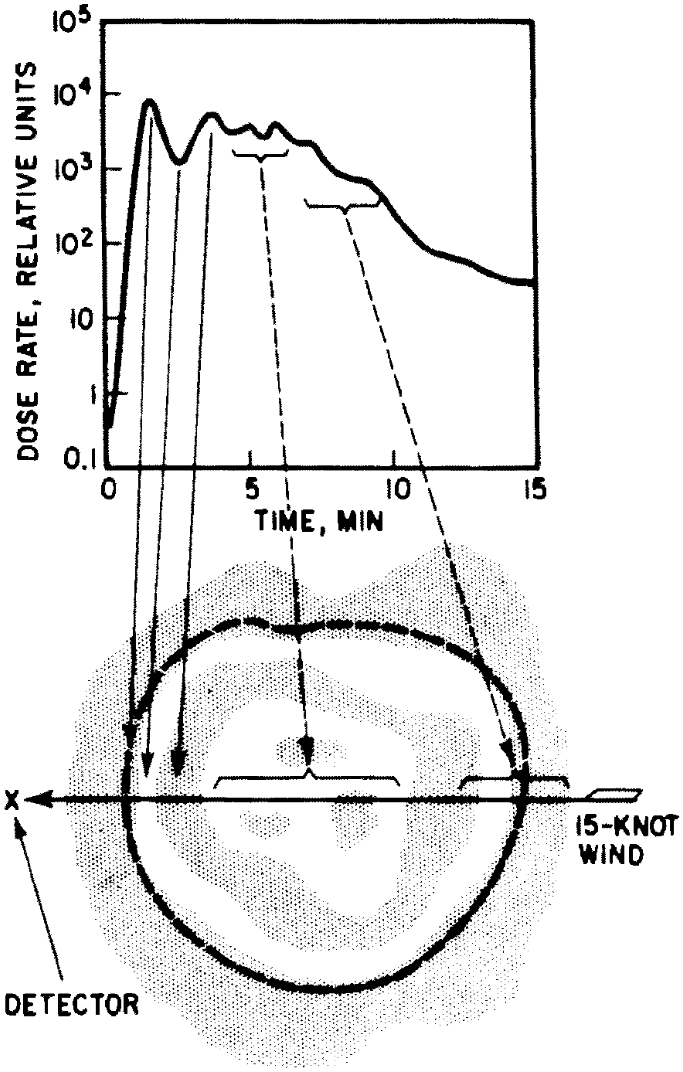


Figure 4-7. Dose Rate vs. Time for a Deep Underwater Burst

4-54 shows the cloud diameter-versus-time relationships. Figure 4-55 gives the dose received by personnel in aircraft flying through an atomic cloud at various times after the detonation.

RESIDUAL BETA RADIATION

In general, the hazard due to residual gamma radiation exceeds the beta hazard for all cases except those in which intimate contact with beta-active materials occurs, as when an individual lies prone in a contaminated area, or when particles fall out directly upon the skin or scalp. For such cases, superficial burns may result, as discussed in paragraph 7-21.

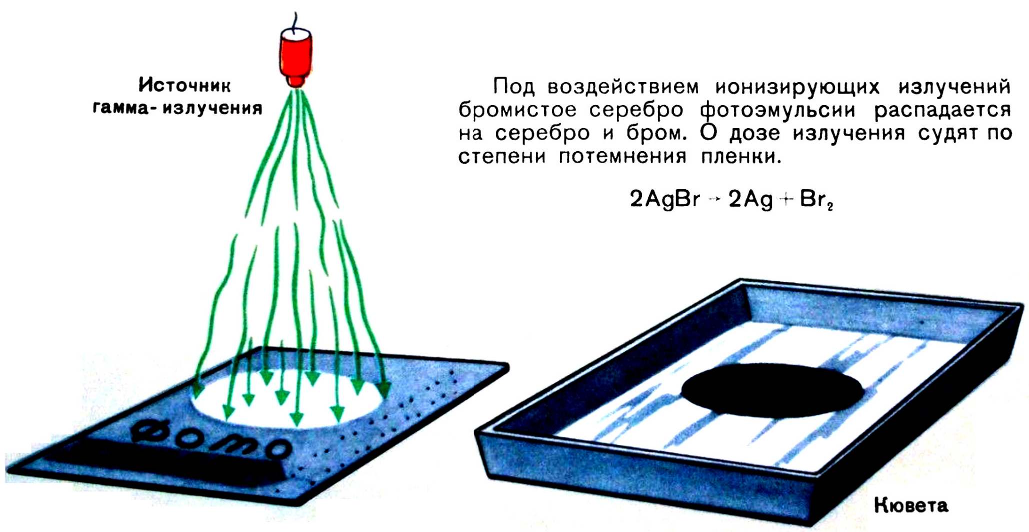
SHIELDING

The dose rates obtained from the contours described, and the total doses derived therefrom, are free-field values that must be reduced if the individual concerned is protected by some shelter. Shielding factors can be estimated from the considerations stated in paragraphs 7-26 through 7-28. For example, personnel in the open in a built-up city area would receive 0.7 of the free-field dose, whereas personnel in shelter such as the basement of a dwelling would receive about 0.1 of the free-field dose.

МЕТОДЫ ОБНАРУЖЕНИЯ РАДИОАКТИВНЫХ ИЗЛУЧЕНИЙ

Обнаружение радиоактивных веществ основывается на способности их излучений ионизировать вещество среды, в которой они распространяются. Ионизация является причиной ряда физических и химических изменений в веществе. Эти изменения могут быть сравнительно просто обнаружены и измерены несколькими методами.

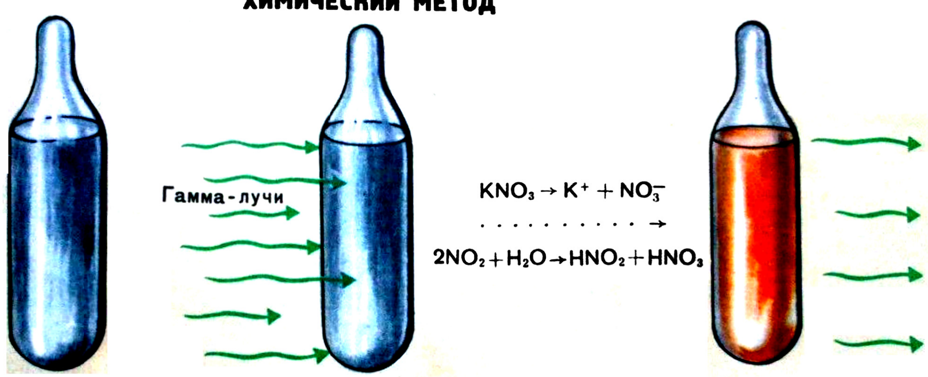
ФОТОГРАФИЧЕСКИЙ МЕТОД



Под воздействием ионизирующих излучений бромистое серебро фотоэмульсии распадается на серебро и бром. О дозе излучения судят по степени потемнения пленки.

$$2AgBr \rightarrow 2Ag + Br_2$$

ХИМИЧЕСКИЙ МЕТОД



$$KNO_3 \rightarrow K^+ + NO_3^-$$
$$\cdots\cdots\cdots \rightarrow$$
$$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

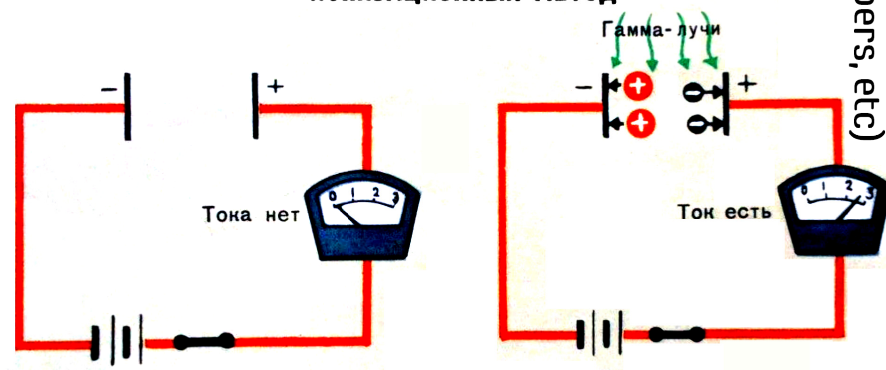
Некоторые сложные химические вещества под воздействием ионизирующих излучений распадаются.

Количество образовавшейся, например, азотистой кислоты пропорционально дозе излучения и определяется по степени окраски добавляемого в раствор индикатора.

СЦИНТИЛЛЯЦИОННЫЙ МЕТОД

Некоторые вещества (сернистый цинк, йодистый натрий) под воздействием ионизирующих излучений светятся. Количество вспышек пропорционально мощности дозы излучения и регистрируется с помощью специальных приборов — фотоэлектронных умножителей.

ИОНИЗАЦИОННЫЙ МЕТОД

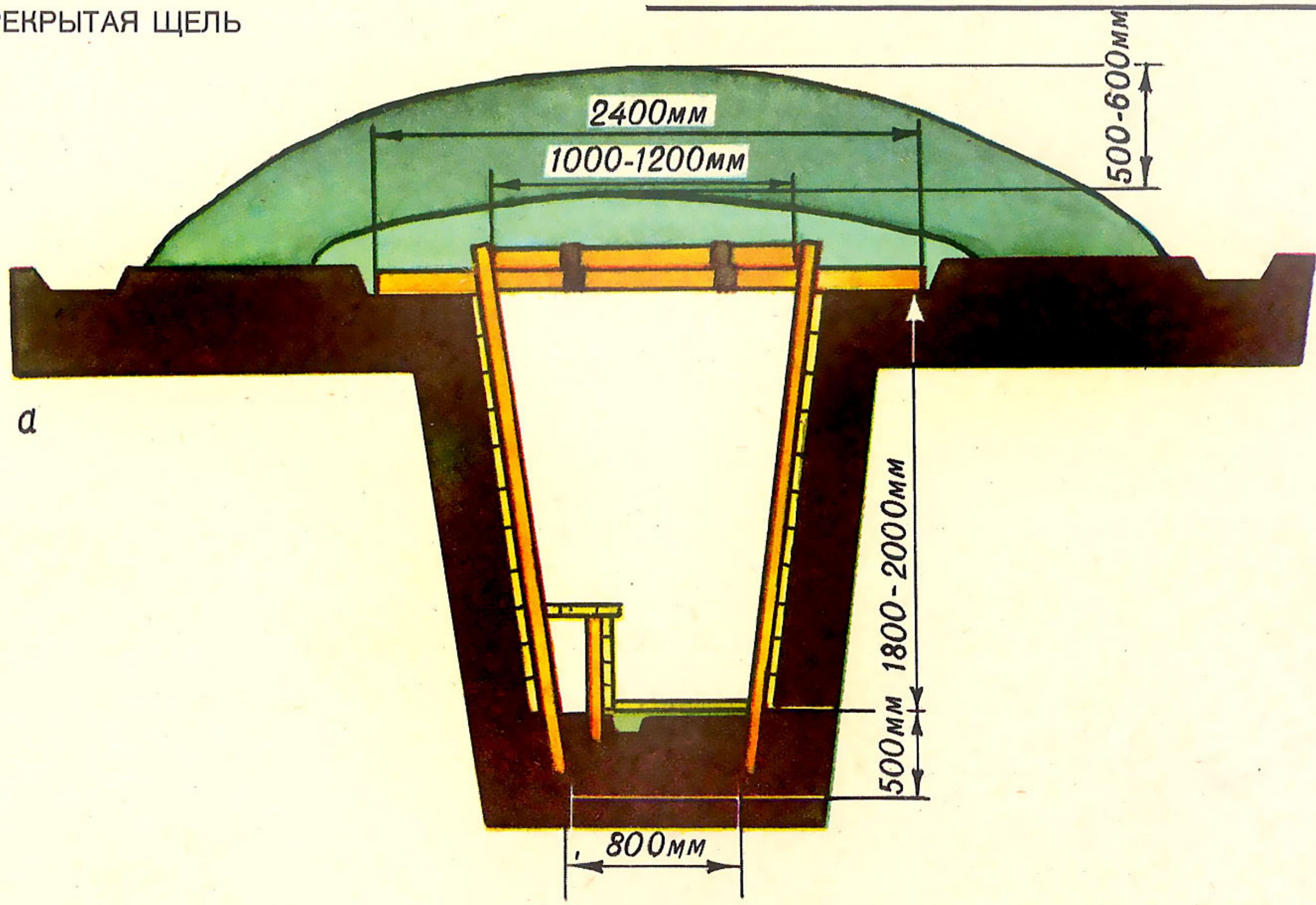


Под воздействием излучений в газовом объеме происходит ионизация молекул газа. При наличии электрического поля в ионизированном газовом объеме возникает ионизационный ток, по величине которого судят о мощности дозы.

Ионизационный метод используется почти во всех современных полевых дозиметрических приборах.

Russian radiation instruments (colour changing chemicals, ion chambers, etc)

ПЕРЕКРЫТАЯ ЩЕЛЬ



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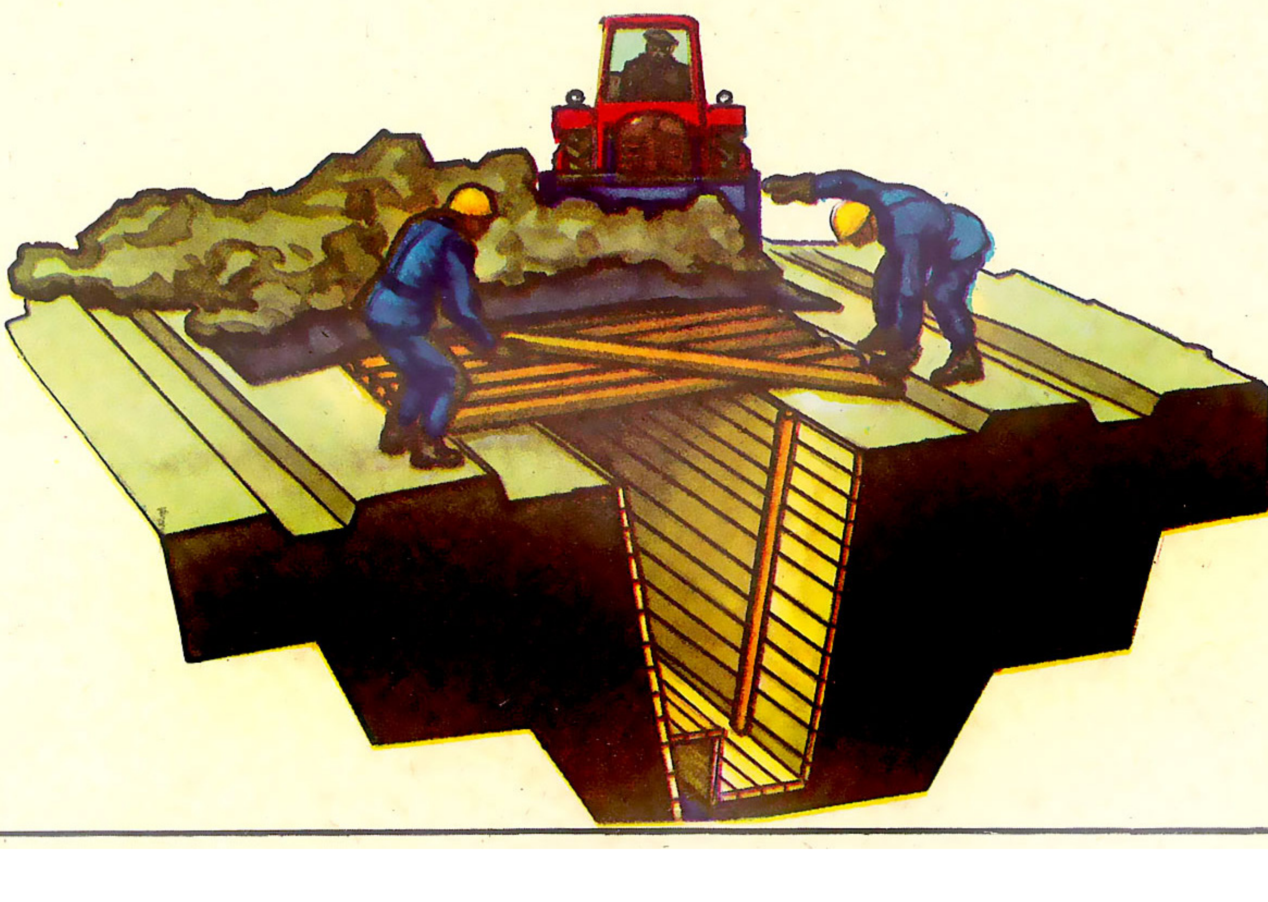

б

Russian nerve gas atropine injection

Russian civil defence drill

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AIR-COMMODORE L. E. O. CHARLTON

Served in South Africa, 1899-1902, twice wounded, mentioned in dispatches, D.S.O.; served W.A.F.F.; European War, again wounded, C.M.G.; Air Attaché, British Embassy, Washington; Chief Staff Officer, Iraq Command; Officer in the Legion of Honour. Author of a remarkable autobiography, *Charlton*, recently issued in Penguins. Has lately established himself as a writer of repute and as an acknowledged authority on air strategy.

G. T. GARRATT

Author of another Penguin Special, *Mussolini's Roman Empire*. Served with the Indian Cavalry during the war, spent 2½ years in Mesopotamia. Correspondent for the *Westminster Gazette* in Germany and Russia. Political Secretary at the Indian Round Table Conference. Went to India and to the Abyssinian war for the *Manchester Guardian*. Spent most of 1937 and much of 1938 in Spain on relief work, observing the effect of concentrated bombing of civilian populations, an experience which gives him special knowledge of the problems he deals with in this book.

LIEUT.-COMMANDER R. FLETCHER, M.P.

Distinguished career in the Royal Navy; served at the Dardanelles, in the Grand Fleet, in the Channel Patrol, in the Light Cruiser Force and at Dartmouth Naval College. After the Armistice he served for three years at the Admiralty as head of the Near Eastern Section of the Intelligence Division. Was a member of the Special Committee recently set up to investigate the progress of British air rearmament and which prepared a Report recommending drastic changes.

The Air Defence of Britain

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CHAPTER I

THE METHOD OF THE AIR

THERE have been many fateful dates in the history of our island since that day, September 28th, 1066, when William the Norman landed unmolested on our southern shore at Pevensey, to inflict a crushing defeat on Harold at Senlac a fortnight later, and to be crowned King at Westminster on Christmas Day. Regarded as a successful feat of arms, it is an outstanding event. There was also something of prophecy in the ruse by which the long resistance of the English was overcome at last. For the Norman archers were instructed, towards nightfall, to raise their bows so as to pitch the arrows at a steep angle of descent in the midst of Harold's "huscarles" and rain them down as missiles from the sky. Something of the same sort, though in nature much more determined, and on this occasion to take citizenry at a disadvantage instead of stout defenders drawn up in serried ranks, occurred after a lapse of 850 years, the date of which should rank with us, and will in the eyes of posterity, as the marking of an epoch. On the 13th June, 1917,

to be explicit, at the noon hour and all unsuspecting, London was reached and raked by eighteen monster aircraft of the Gotha type, the bombs falling in clusters from East Ham to Finsbury, and accounting for 594 casualties, of which 162 were killed outright. There was even something of prophecy, again, in this visitation, for an infant school in Poplar was the scene of one attack, and forty-six small children in the kindergarten stage of life were blown to pieces, thus foreshadowing the peculiar aptitude of the aerial bomb, later to be evinced in Barcelona, for the massacre of innocents.

These Gothas were twin-engined aircraft capable of flight at 80 miles per hour, and could carry a dead weight in bombs, additional to protective armament and crew, of 660 pounds. They could stay up on a full-tank capacity for four and a half hours, and were specially designed for the air bombardment of England from the Channel ports. They were the prototype of the modern heavy bomber, though it is almost ludicrous to compare the then and now. To-day the lineal descendant of the Gotha, belonging as it may to any air force, large or small, has thrice the speed, four times the carrying capacity and five times the range. Such is evolution !

In those days, so far away to the rising generation and yet so short a while ago, aircraft had no free scope as an independent arm. Aviation was tightly tied to the apron-strings of military commanders in the field, and was strictly tethered to the needs of armies for Cinderella use. But the

law of evolution works in thought as well as in practice, even to the dumbfoundment of strait-laced generalship, and at present it is universally acknowledged that the air arm has a strategical and unilateral *raison d'être*, the purpose of which is to be the spearhead of aggression in the hands of an aggressor, or equally the reprisal weapon for the counter-attack of a defender. Let us briefly examine either claim and endeavour, thereby, to assess what likelihood exists of the bomber becoming king of all.

Most people are apt to think of air bombardment merely as an appendage of ordinary warfare. But it is much more than that, and it so differs from the usages in vogue, commonly the attributes of forces opposed in the field, or of ships stripped for battle on the seas, that it is not too much to say that it is a revolution in the art of war, rather than a mere technical extension of the modes of combat. War in any case is a means to an end and not an end in itself. It is the fisticuff continuation of a political argument, dispassionately considered, wherein the acerbity of notes exchanged develops at a certain point into the sharper altercation of blows. What is the actual purpose for which war is waged? Certainly not for mere reasons of slaughter, either of an unarmed civilian populace or of men trained to arms. The ultimate object of war is, by means of armed force, to brush aside opposition and to march on the enemy's capital, the victor from that commanding position being enabled to dictate terms of peace. In democratic countries, and even, eventually, in authoritarian states, it is the people

themselves who have the last say in the matter, for no Government in the world could prolong resistance in the face of an expression of growing popular dissent. Hence the invader's extreme desire to march ahead, and the bloody battles which are fought *en route*, possession of the principal city being a symbol of conquest for all the world to see, besides being a centre of occupation from which the life of the invaded country can be slowly stifled until the remaining sparks of national resistance cease to glow. Such is the chief object of war with so-called civilized communities, and the main objective of attack is not, as many are apt to think, the army of the defender, but the populace itself, and especially that large section of it which inhabits the principal city and which can bring a pacifist influence to bear on their rulers if it finds the rigours of existence unendurable under the regime of war.

When this is once appreciated the role of aircraft assumes a new significance, and it will be proper at this juncture to explain the salient distinction which divides the new form of warfare from the old. Ever since the nations of the world emerged from the chaos of warring tribes to form themselves into settled communities under a common flag their home and foreign policies have been directed towards the one, single necessity of security. Indeed, the very frontiers were largely delineated with that end in view. The mountain barrier of the Pyrenees is a natural strategical division between France and Spain. The Alps neatly enclose the northern frontier of Italy, and the sea does the rest.

In the absence of hilly tracts we find a broad river serving the same purpose, as the Rhine in western Europe, the lower reaches of the Danube, and the Dniester in the eastern portion of the Continent.

When neither mountain range nor river serve, a swampy district will suffice, as witness the Pripet Marshes which now roughly demarcate the boundary between Poland and the U.S.S.R. On the landward side a strategical frontier formed by the hand of Nature was sought as adding to territorial security, while seawards countries made haste, wherever possible, to reach the coast and secure themselves by means of the salt-water belt which lapped their shores. When the framers of the Peace Treaties, in 1919, carved up Austria-Hungary to create the new State of Czechoslovakia they had the principle in mind, and included the Sudeten Germans in its boundary because the mountains of Bohemia formed a strategical frontier in that particular part of central Europe. Warfare in those days, and even up to now, meant the cut and thrust of opposing forces on the ground. Armies crawled wormlike in two-dimensional space, and the natural obstacle of mountain, river, marsh or narrow arm of sea provided strength against invasion and eased the task of the defenders. The best situation of all was to be an island nation, for the sea was the strongest barrier which Nature provided. This has been our situation ever since the union of the Kingdom, as a result of which there has never been a serious threat against the security of our shores, and no fighting whatever on land excepting civil war,

while the Continent, so nearly adjacent to our southern coast, has seldom had a respite from unending conflict.

The science, or art, of war grew up in keeping with these conditions and assumed, likewise, a barrier formation. Fortifications were erected for the improvement, or extension, of Nature's line. That we are still in this stage of military development, despite the menace from above, is proved by the existence of the French "Maginot Line", and other systems of the sort now a familiar feature of the European landscape, which have been constructed largely underground to form an artificial barrier to invasion where the give and take of past wars has resulted in an unprotected boundary. Secure, or as nearly so as possible, behind their natural and artificial barriers, whether composed of physical features on Nature's grand scale, of bricks and mortar or of reinforced concrete, of a living line of men drawn up in battle array, or of opposing fleets at sea, the nations did not shrink from the arbitration of war in the final issue of events. They were strengthened, sometimes, by the righteousness of their cause, but more so, and more often, by the surer realization that as long as those walls were neither breached nor overtopped they might sit in safety and defy the foe.

The fact that fighting could only take place on the surface of land or sea did more, however, than shape a military technique. In the interludes of peace the ceaseless search for security still went on, and diplomacy was put in play to make, or

accomplished in complete neglect of what transpires on the ground as regards the set-to of armies, or of what takes place at sea when fleets join battle. Air action, thus applied, in certain circumstances may so defeat civilian courage that a popular cry for peace at any price arises, and the Government, deprived of the support on which it must needs rely in order to prosecute the war, has no option but to ask an armistice and accept what terms are given. We have an instance in the late war of the effect on hostilities of a people driven into revolution against their rulers because they were called upon to suffer beyond endurance. Far too little attention has been drawn to the fact that the German armies, though in retreat, were still in fighting trim when the change of government occurred, in 1918, and the Kaiser was deposed. It is a lesson which we, for reasons later to be given, should not neglect, and it runs like this.

From the very commencement of hostilities the British Navy rigorously enforced the laws of blockade against the Central Powers, frequently embroiling themselves with neutral countries in the process, but facing all suchlike risks, and the consequences therefrom, rather than, for a single instant, to relax an effort which must logically conduce in the long run to victory. The length of the run, it so happened, was about four years, at the end of which time the throttling process was having full effect. With the exception of the soldiers at the front, who had to be fed, the entire population was undernourished, and the city folk especially were reduced in large measure to a condition of semi-starvation,

as are the inhabitants of Barcelona to-day. In addition they were woefully ill clad, and most of the amenities of life, particularly those which had to do with fuel, and light and heat, had either been withdrawn or were greatly diminished. It is common knowledge that the germs of disease fasten on a subject which has been weakened through privation, however constitutionally strong it may be, and in obedience to this law the subversive elements in Germany found a wide and fertile soil for the seeds of rebellion which they proceeded to scatter. The result is as we know it. With this ferment on the home front the military might of Germany collapsed, and the war was brought to a sudden and unexpected conclusion because the national will to fight had been broken beyond repair. During all that dreary day in which the opposing armies had been stagnating at the front, a slow and insidious process had been in operation, the strangle-hold of blockade, and the large offensives in Flanders and elsewhere, with their terrible toll of life on either side, the enormous energies outlaid, and the huge treasure wasted, did not sensibly affect the final outcome, which was due to the invisible pressure of our Navy against the real point of resistance, the people's will to war.

It is quite obvious that we have not taken that useful object lesson to heart, for otherwise we would not have delayed rearmament until the potential enemy was far and away ahead and out of sight, particularly with reference to air power, that post-war weapon which, owing to our peculiar circum-

stance, is calculated to do to us, and in much quicker time, that which our Navy did to Germany over four long years. Germany has not forgotten the lesson she received, and with good reason. We charged her with baby-killing because her cruisers shelled an East Coast port, and because latterly her aircraft dropped their bombs without discrimination on city centres. But indirectly we were baby-killers, too, of a much higher order, by inducing food shortage in the enemy country, as the health reports in Germany for the later period of the war fully bear out. It was legitimate warfare, and well it served its purpose, so much so that it would be sheer folly for our late enemy not to take advantage of the situation now that the tables are turned, and do to us, if war should come again, as they were done by. Such methods have a boomerang effect when opportunity serves, and if ever the time does come once more to submit affairs to the arbitration of war, the air arm now exists as a weapon precisely fashioned for the purpose of an aggressor.

There is still a vast amount of ignorance about concerning the application of air power. People in this country, for instance, reflect comfortably that all will be well with them in this respect as long as they possess strength in the air equal to that of the enemy. Why this is a fallacy which may have a tragic significance one day, and how different such equality is from being able to give as good as one gets, will be explained in due course. If two opposing air forces merely cancelled each other out, only leaving destruction in their wake, war

=> SURRENDER + OPPRESSION
would become too farcical a game for even dictators to play. Again, there is a considerable body of opinion which claims that a sufficiency of fighter-interceptors, together with a barrage belt of anti-aircraft batteries, could successfully defend a locality, either keeping the invaders off or shooting them down from the sky. The situation is not yet in sight when air defence can be counted on to counter air attack, and this also will be dealt with in its place. There are others, and among them men of eminence in Parliament, including Mr. Winston Churchill, ex-Secretary of State for War and Air and one-time First Lord of the Admiralty, who maintain that events, both in Spain and China, go to prove that in spite of much damage and inevitable loss of life, bomber attack on cities is not of that decisive nature which assists to victory. Let us examine this last contention in the light of what may happen in the future, for the argument lies near home to us and the truth should always bear examination.

Of the destructive effects of bomb attack, considered in relation to the after-results of the individual bomb, we have had ample experience during the air raids over England in the Great War, while the modern spectacle is outstandingly before our eyes in regard to the two aforesaid countries. Indeed, the matter does not require proof. Reduced to its essentials, the aircraft is itself a projectile, just as truly as if it were fired from a gun, and the actual dropping of the bomb can be likened to the bursting charge of a shell when it arrives. There is, however,

in all three cases. Air power to be effective must be applied at full strength and with sustained effort. It must be used in a totalitarian sense, with single-purposed endeavour and with one main strategical aim, to cow the people into the mood of surrender. That is how its future use is foreshadowed by the two central European dictators who have amassed air power and are constantly adding to it. From their own mouths, and through those of their spokesmen, they have let it be known that they will attack cities with ruthlessness by means of the aircraft fleets they have in readiness for war. And why, indeed, should they not, knowing full well, as they must, that big cities are the nerve centres of a country, and wishing for a quick war? Not during the Great War, and neither in Spain nor China to-day, is this condition being fulfilled. Germany never hoped that her air attacks on London would bring victory to her side. At the most she aspired to cause alarm and despondency, to delay munition output and to constrain us to withdraw guns and aircraft from the front in France for the needs of local defence. In all these aims she well succeeded and, as regards the latter, it is worth while to note that in each case it was popular clamour, rather than a strictly military necessity, which induced the Government to elaborate the various schemes of defence until the odd score of Gothas employed in raiding were immobilizing, on the home front, more than twenty times their number. The Germans only utilized their surplus energy, for the paramount need in the eyes of the military High Command

was the front-line battle waged unceasingly in the air, and aircraft had not then been considered as a separate weapon of war. The new arm was still in apron-strings to the old, and jealously regarded.

In Spain and China, curiously enough, both invaders are in the Great War stage of development as regards the use of aircraft, though the equipment which they dispose of is modern and up to date. Franco does not possess enormous air power, greatly though it may exceed that of his adversary, and he has found great use for it in battering the front-line systems of defence where the air opposition is slight. The early air raids on Madrid, and the later ones over Barcelona, Valencia, and other coast towns, were all sporadic efforts carried out by small formations and bear no resemblance to the unintermittent day and night attack which will be the mark of the war to come when great powers go to work. Moreover, a temper is aroused by civil war which has no counterpart in a struggle between nations. It was always much easier for the British soldier to dislike the French than to hate the Germans during the Great War, looking on the latter as people who were in the same pickle as himself and worthy opponents at that. But in Spain there is savagery of disposition on both sides, and hate bordering on frenzy, the result of which is to harden resistance on the part of the defender and dispose him to welcome death rather than surrender and lose the fight for liberty into which he has put his all. Chiefly, though, the war in Spain came gradually nearer to the city populace, who were not

called on to endure the sudden and obliterating effect of massed air attack out of, so to speak, a blue sky. They were inured to the condition before they felt the full impact, and disorganization of life with its accompanying hardship and suffering had set in before the air attacks could take them by surprise. Anything can be borne if the cause one fights for is a righteous one, and as long as the body can secure enough food to support life. The truth is, however unlikely it may sound, that the cities of Spain have not as yet experienced, and probably never will, the sort of air attack which the near future holds for us unless the sky of Europe clears. The courage and endurance which they have shown is great, but these are hardly a tithe of the display which will be necessary when bombers, to be counted in their hundreds, appear over London.

In China somewhat of a similar situation obtains, though the people there are long-enduring for a different reason altogether. Japan is a much militarized nation, with the war-lord and the politician so intermixed in nature that it becomes a dual personality. The Navy and the Army are in power over there, and there is no Air Force as a separate and strategic arm, such as occurs in Europe with our own and other countries. In consequence, when war breaks out, or, better still, when "incidents" occur, her air power is fettered to the other services to subserve a purely naval or military end, and is only released for long-distance action at the instigation of a naval or military commander. Shanghai suffered greatly under air bombardment

when its immediate vicinity was the scene of action, and so did Nanking as the Japanese advanced. But the raids on Hankow, or on Canton and other localities of military importance far afield, though not infrequent, have never been conducted as a major enterprise and have seldom been attended with very great success. The cramping effect on air power when it is in tutelage to other arms is here painfully apparent to a trained observer, especially to one who was able at the time to realize, during the Great War, what opportunities for effective action were missed owing to the dependence of our Air Force on the General Staff. The Japanese may be right, however, in this instance, for the bombing of a Chinese city when it is not immediately in the line of next advance might easily become a waste of energy. For the vocal clamour of a Chinese city populace would be inaudible to its rulers amid the stress of war. The teeming millions in China are born to sorrow. Flood and plague and famine have been their lot for years, and they have become submissive to disaster as no other population in the world. The masses, it is true, are now awakening, but the percentage of the total which is racially and politically conscious is a meagre number indeed. There is no opportunity here for the bomber to break the spirit of resistance by attacking the popular will, for the spirit is bowed already to suffering, and the will does not rest with those who mostly suffer.

Such, mainly, are the reasons why air power has not been decisive of events in either Spain or China.

It is important that they should be realized, for far too many people are drawing a false deduction and imagining, in self-complacent fashion, that air attack is not to be so greatly feared after all. Surely, they say, we can undergo the trials which these people are so bravely coming through! Our courage is as great as theirs!

It is not a question of individual courage, but of mass psychology. We have not been put to the test, nor has any other country in the world as yet, and it is sheerly impossible to predict what behaviour will result when the trial is on. Highly centralized communities which are hand fed by the services of public utility are in a different category to those of lesser development which are either brutalized by their condition, as in China, or systematically exploited, as in Spain.

Let us try to picture next the effects, as far as they can be foreseen at this stage, of a real exercise of air power over a huge metropolis. For our purpose let us take London.

CHAPTER III

LONDON THE LOADSTONE

At this present moment we are very busy devising means for the protection of this great city of ours, than which there is none bigger in the world. It is worth while, perhaps, to remember in passing that it had a military origin, for the Londinium

to spoil the war. But supposing the civilian insists on spoiling the war! What if it were unendurable to him? What then? Germany possessed a proud citizenry prior to her collapse in 1918, which supported the war in heart-whole fashion. And yet she found the limit of endurance. Have we more resilience, and a greater capacity to bear duress than the Teuton, who is racially our blood brother? The trial under which they bent in Germany took four years to reach its climax, during which they were naturally inuring themselves until the breaking strain was reached.

The coming war, for so it must be called, will burst like a storm-cloud overhead, giving no opportunity for an acclimatizing process, and with no more warning than an avalanche. Why should there be warning? Formal declarations of war are out of fashion nowadays. And did not Hitler, when the Anschluss was proclaimed, dispatch 200 bombers to circle over Vienna while the ultimatum given to Schuschnigg was expiring? They were overhead for demonstration purposes, because Hitler knew surrender to be certain. But if his calculation had been wrong, or if a single anti-aircraft gun had fired at them, is there anyone to doubt what would have happened, or anyone unable to picture the result?

The art of military strategy, according to the best authorities and from the point of view of generalship is to find a weak point in the enemy's defensive system and then attack it by surprise. It is a question of material damage to an adversary's defences

produced for that specific purpose, and which he knows to be superior to that of his opponent. Atom Bomb.

It is little recognized in matters to do with air defence that the whole balance can be completely upset by a sudden step forward in improvement of performance, by an advance in the science of bomb manufacture, or by the discovery of some mechanical contrivance which would increase the fire-power of small cannon and machine-guns, all of which can be secrets closely guarded until the day arrives. Imagine, as an instance, that in the Great War the interrupter-gear, enabling fixed guns to be fired through the airscrew, had been an invention exclusive to ourselves and that the Germans were long incapable of copying it. The result would have been complete mastery of the air, for the anti-aircraft gun of those days was quite ineffective. It is not too much to claim that the total absence of air power on the enemy's side, thus brought about, would have sufficed to destroy his military morale and hastened victory. Such a little thing would have had that vast result. Something similar would have the same result to-day.

It is thus seen that parity, which can only mean a rough equality in numbers of types, must always put the non-aggressor at a disadvantage. In the first place there would be no possibility of agreement on the subject and it could only be achieved by mutual arrangement. In the second place, even supposing agreement were come by, complete reliance must be placed on good faith for the observance of the contract, for no system of surveillance could

be devised accurately to check up on construction in secret. And thirdly, the child of an inventor's brain might quite suddenly so increase the offensive power of attacking aircraft or the defensive power of defending ones that the equality would be that of the hawk to the dove, merely because both are birds.

This very talk of air parity, and the way the word is bandied about in and out of Parliament, as if it were our bottom plank of policy, is merely proof, if further proof were needed, of our complete failure to separate our thought from the older forms of warfare by sea and land. Navies fight other navies, and armies fight other armies. They can measure up against each other, and if the forces pitted in the field, or on the sea, are approximately equal, then victory will go to the side whose leaders have the better brains, or whose rank and file are braver. That is fair enough. But air forces do not fight like that at all. They have no natural enemy to bar their progress and fight it to a finish. Even if it were not so, indeed, and a battle between air armadas could be staged above, even then it could only come about by mutual consent, so vast is the power of evasion which the immensity of space confers. The Italian General, Douhet, dreamt like that, and argued neatly from it that the battle-bomber, a veritable armoured cruiser of the sky, must be the primary arm of national defence, to act offensively and compel surrender while the forces by sea and land assumed a passive posture of defence.

Constructional development may be, though without set purpose, taking steps towards the fulfilment

were chalked " *a' Berlin* ", and on the German side, " *nach Paris* ". These inscriptions, it is true, were part of the ebullience engendered by war-fever, and derisory besides, but they did express subconsciously the instinct to grasp that symbol of victory which possession of the enemy capital will always grant. Why did Napoleon, in 1812, brush every military obstacle aside and march on Moscow? Because in his consideration the fall of her capital would settle Russia's hash. In the Franco-German war of 1870 the siege of Paris, and the subsequent march of victory by German troops through Napoleon's " Arc de Triomphe " were calculated to impress the rest of France with the uselessness of further resistance. By occupying Bloemfontein first, and Johannesburg later, in the Boer War, we were acting in true conformity with the principle of possessing ourselves of the enemy capitals in order to enforce surrender, though vainly, as it so happened, owing to the nature of the terrain and the peculiar aptitude of the Boers for guerilla warfare.

Even in Italy's recent Abyssinian campaign, for proper conquest it was not, the semi-savage defenders of their country were supposedly to be counted out as soon as the capture of Addis Ababa occurred. Take it all in all, in little country or in big, the heart of national resistance will still reside in the principal town or city, and the symbol of conquest will be its occupation. In that one particular way war has not changed, and the advent of aviation saw the dawn of that day, now, a quarter

of a century later, fully broke, on which the regiments of bombers can, and will, do more devastation, in an inconceivably short space of time, than ever siege artillery could do to subjugate the inhabitants of a country's capital city. Military opinion still stoutly maintains that effective occupation can alone ensure the downfall of a city and the surrender of a Government, and that accordingly air bombardment cannot do it. But if the people's lives are broken, if a state approaching famine stares them in the face, if they are largely homeless, if they do not know which way to turn for succour, if every service is suspended, and if the bombers keep on coming, then such a city is as effectively occupied as if the pickets of the enemy guarded every crossing and martial law were being rigorously enforced by firing-squads.

The greater the extent of ground which it covers, the more ineffective the measures which are taken for the passive protection of the populace, the larger the area of surrounding country which is dependent on it, and the less inured to mass discipline its people are, so much the more vulnerable will that city be. If two capitals belonging to two countries at war suffer air bombardment from their respective air forces, with approximately an equal number of bombers on both sides, and a similar capacity for carrying bombs, that one with the greater vulnerability on the above-mentioned lines will be the first to voice a demand for peace, and that country of which it is the seat of government will be the first to sue for terms. The conclusion cannot be escaped that we must enlist much

of security would gradually eclipse the fear which is reigning now, national armaments, little by little, would be reduced, and eventually, it might be, the supra-national air force would stand alone as the policeman of the world.

Meanwhile, however, there is the present to consider, for this force could not be assembled in a day, and, more likely, would take as long as five or seven years to reach a necessary pitch of efficiency. There is no escape from the immediate necessity to rearm, and as regards our own particular air rearmament, it should be even on a larger scale than is envisaged. No harm is done thereby to the principle of peace, for as the supra-national air force grows and waxes strong, and as the shadow of war on that account retreats, surplus equipment can be handed over to it for its special use. If we, for instance, could only adapt our sight to look on rival air power as once we regarded the growth of Germany's rival fleet, then nothing could restrain us from building up our air strength, in spite of cost, until we came to have a lead so great that she would give up the race as hopeless. We have done it on the sea, and now, the times being changed, we must do it in the air. It is not a question of finance or budget-balancing. We are at the commencement of a new era in warfare, and in deadly danger. Posterity must pay its whack, for it is being insured, and the present generation must not be constrained from motives of quixotic honesty to foot the entire bill. => RUN UP A DEBT!

Aircraft production is needed on a scale surpassing

any which has yet been taken into account. We are now attempting to provide this need without interference with industry at large, as if a man should add another story to his house when the lower walls are cracking. Even considering the comparative modesty of the present programme, we are not able to produce the goods, and meanwhile the rival whom we dread, and with good reason, too, has made, and is still making, her national effort under a dictatorial regime, and is becoming the hare to our tortoise in the race for life. This matter of a halting production of the aircraft programme now on order is dealt with in the succeeding section of this book. It only remains to say here that our industiral resources are equal to any demand if only the clamp of officialdom can be thrown off and trained intelligences be given full play.

In another respect, as well, we are dabbling with a subject which requires universal and heart-whole endeavour, and that is in the matter of Air Raid Precautions. There is no grasp about our handling of this life-or-death affair. We run from pillar to post, taking up one aspect to the exclusion of others of equal, or greater, importance, and then reverse the process, quite unheeding of the lessons which are before our eyes in Spain and China. There at least the bomber is enacting its role, and if, in our own predicament, we fail to take advantage of the grim lessons so afforded, we shall come to rue the day.

Part II

AIR RAID PRECAUTIONS

BY

G. T. GARRATT

CHAPTER I

ATTACKS ON CIVILIANS

It is now generally admitted that in any future European war we must expect air attacks directly aimed at non-combatants as well as raids on military and industrial objectives. The next three chapters will be devoted to what is known as Air Raid Precautions or A.R.P.—the passive side of air defence. The rest of this book has dealt with the wolves who do the fighting. We must now consider the sheep. How can they best be fenced round, and huddled away, so as to have as few losses as possible and to be no trouble to their own wolves. But just because this analogy is not really accurate, and the civil population of a democratic country is not entirely ovine, there is a third side to the precautions which must be taken before and after the beginning of hostilities. We have also to consider the probable behaviour of the non-combatants when exposed to certain experiences.

Air Raid Precautions can, then, be taken as having three main objects. (1) To avoid as much damage to life, limb, and property as possible. (2) To

release as many aeroplanes and soldiers as possible for carrying on aggressive warfare. (3) To minimize internal troubles and dissensions which would endanger the country's efficiency in carrying on the war. These three aims may, for our convenience, be described as humanitarian, strategic, and political. It is essential that we should keep these ideas separate in our minds. It should not be assumed that methods suited for one purpose will also assist the others. To some extent the objects are mutually imcompatible. It is good, strategically, to persuade people that they are safer than they really are, in order to prevent them politically clamouring for more interceptor planes to be detailed for their protection. It may be good, politically, to tell Londoners that certain expensive forms of protection are not practical. We will return later to the weight which has been assigned to each of these considerations in our own A.R.P.

There is, fortunately, no need in this book for the evasions and reticence which characterize all political and most Press references to this subject. If our A.R.P. have not been taken sufficiently seriously in England, it is because the whole business has been surrounded by an atmosphere of " make belief ", which is fatal to efficiency. To anyone who has been working in eastern Spain, where air attacks were part of one's normal life, the arrangements now being made in London and elsewhere seem hopelessly amateur and casual. It is rather like returning from the last European war, and being

their best machines and materials, or whether they have abstained from using certain weapons, notably gas bombs, for reasons which would not apply in the case of an attack on London, Birmingham, or Manchester. We do know that they have used their good pilots, and that the men who would bomb London are mostly the same as have led the attacks on Spanish objectives, so that we can expect something of the same technique as they will have tried out themselves or watched the Italians doing.

Most of the German bombing has been directed against the smaller towns of northern Spain, in an area without any serious anti-aircraft armament, and denuded of fighting aeroplanes. More interesting from our standpoint has been the work of the Italian aeroplanes operating from the Italian mainland or more usually from the Balearic Islands against Barcelona, Valencia, and Alicante. Their method was to come over at a great height, shutting off their engines for the last stage, so that their arrival was almost soundless. They dropped large high-explosive bombs, whereas the Germans, operating against the older and more combustible towns like Guernica and Durango, made greater use of incendiary grenades.

The modern bomber is a very speedy machine, about three times as fast as the "Gothas" and "Giants" which raided London during the last war. The Gothas then carried about half a ton of bombs, and the Giants nearly a ton. Their most effective raid was on June 13th, 1917, when seventeen aeroplanes dropped 128 bombs, killing 162 persons,

and injuring 432. It seems to have taken about a ton of bombs to kill twenty people. The modern bomber does not carry much more weight, but its speed is 250 to 300 miles per hour, and it has a considerably higher " ceiling ". A slower machine would have little chance against interceptor planes. During the attacks on Madrid in the early part of 1937 the German bombers, though flying too high to aim at definite objectives, usually lost one or two out of a dozen machines, but these were the second- or third-class stuff which Herr Hitler contributed in the early days.

The explosives seem to be about twice as effective as those used in the last war, but evidence on this point is difficult to get. During twenty-three bombardments of Barcelona 528 bombs were dropped, causing 916 deaths, 2,500 wounded, and destroying 863 houses. The subsequent attacks in March and April were relatively more severe, but in no case has there been evidence of any specific objectives except the general target of an industrial area.

A combination of common sense and experience would suggest that we are likely to be subjected to mass attacks on thickly inhabited industrial areas. The object will be to kill off as many working men and women as possible, to put out of action some factories, which if the enemy are lucky may include some power stations and key industries, and finally to have an adverse effect upon our morale, partly from fear, and partly by setting the working classes against the rest of the population and especially against the Government.

motor-cars, and there were very few privileges for those with money. The small pro-Franco element kept extremely quiet.

For many reasons the Germans are not likely to be deterred by their Spanish experiences from planning their air raids with a strong political bias. There are a number of tacit and quite unjustifiable assumptions about our A.R.P. We have no reason to expect that the next war will begin in the least like the last. The Fascist mentality and methods of diplomacy entirely exclude the probability of a formal declaration of war as between one united country and another. General Ludendorff laid it down as a guiding principle that a country which had decided to go to war would lose a great advantage if it did not begin by a surprise raid aimed at paralyzing the enemy's nerve centres. The Fascist State will also want to use its advantage in having complete control over the lives and even the thoughts of its own people. Their usual technique is, therefore, to stir up trouble in another country, and then interfere forcibly and decidedly.

This technique has been worked by Germany in Austria and Spain, and by Japan in China. It would be a mistake to assume that something of the kind would not be tried in England, or that the hard-bitten German politicians of 1938 will necessarily be so maladroit as the rulers of the Kaiser's Germany, who expected risings in India and Ireland immediately after the declaration of war, though they had done little to ensure them. The Nazi leaders will probably not look for much help in

either of these countries, India or Ireland, but they will expect some help inside England. There are considerably more signs of Fascist activity, and more avowed Fascist sympathizers in high places in England to-day than there were in Spain in 1935. Decent Spaniards did not then know that Spanish Fascists were actually intriguing with Italy and Germany; we know equally little of what has been done by Fascists in England.

The Germans may well hope that a raid, aimed at the chiefly "left-wing" East End of London and carried out while the Government is ruled by a very "right-wing" Government, may cause a serious split and lead to large-scale fighting or rioting. The A.R.P. instructions seem to envisage some time for preparations after war has begun, and completely disregard the political dangers—a subject to which we must return later. There is a kind of picnic atmosphere about our precautions, a reliance on our genius for "muddling through". This worked well enough in the age of horses, but will not necessarily save us in the new mechanical world which is so much less suited to our national "tempo" and characteristics.

We were very lucky in 1914. The country may never be so united as it was under the middle-class Liberal Asquith. It is certainly not united to-day. The suspicion aroused by the attempt to form a wealthy one-party Government in 1931 has been immensely increased by the lamentable deceptions and evasions necessitated by our foreign policy since 1935. The Abyssinian and Spanish affairs have

in his house, keeping his children with him. He is to make a room gas-proof, turn on the wireless, and wait quietly until the storm is over. If he is a person of independent means, he is to take himself, and his pets, to the country, presumably in his car. One detects at once a certain middle-class bias, a feeling that "an Englishman's home is his castle", and an outlook engendered by living in detached, or semi-detached houses, or in London mansions well shored up and separated by thick walls. For those so situated the advice is not inept, though if you have a garden it is still better to make a crooked trench and sit in it, with or without the wireless.

Unfortunately it is Shoreditch rather than Surbiton which is likely to be raided, and East Woolwich rather than West Kensington that may be blown up. From the strategic and political standpoint there is much to be said for assuring people that if they sit at home and take a few elementary precautions they will probably be safe. The chance of being killed or injured in an air raid is comparatively small, and most normal persons get to look at raids in that light. An air raid which killed and injured 70,000 people in London would be out of all proportion to anything which has happened up to the present. It would mean dropping a thousand tons of bombs, by no means an impossible feat, but perhaps as much as may be expected in a single raid. The chance of any particular Londoner being amongst the first 70,000 is only one in a hundred, a chance which a healthy-minded person

would not take too seriously unless it was going to be repeated several times. It is therefore good tactics to tell people that they should stay at home, seal up their windows, or retire into the cellars rather than go on to the streets and discuss the situation with their neighbours. But it is dishonest to make people believe that the precautions have much to do with their chance of escaping injury or death. ← FALSE! FLYING GLASS KILLS.

It is difficult for anyone who has seen the condition of a bombed industrial area to take the protection of individual houses very seriously. The high-explosive bombs shatter and crack all except the first-class steel-framed buildings within a considerable area. Yet the A.R.P. instructions seem to envisage a very modest use of high explosives, but give much attention to gas bombs, and the small thermite grenade which has not been a great success in Spain. The Spanish Government at first took something of the same line. They were dealing with a people at least as individualistic as the English. Painstaking officials busied themselves with handbooks and posters about gas precautions, and where to stand in your house when it was being bombed. It is doubtful if carrying out these instructions to the letter would have made a difference of more than one or two per cent to the casualties. ✗As to cellars, these were often sheer death traps; the effect of a "delayed-action" bomb is to bring the whole building, except the outside walls, down on the cellar, thus threatening a peculiarly horrible death, unless a very powerful man

with a pick-axe could hack his way out before being suffocated.

It is a little difficult to understand the A.R.P. emphasis on gas precautions. The use of gas is, of course, forbidden in sundry conventions, and its employment against non-combatants was considered, up till 1934, as sheer barbarity. During the Ethiopian war, when our policy was to hasten the end of Abyssinian resistance, and rehabilitate Italy as a civilized power, our Government was at special pains to minimize or deny the Italian use of gas.[1] It is curious to find that, although it has not been used in Spain, either in battle or against civilians, it should loom so large in A.R.P., and that a Government with so many prominent supporters who are strongly pro-German should assume that the Germans will begin to use gas from the first in its most indefensible manner—against women and children.

We may, however, be right in considering that the Germans will not refrain from any weapon in order to bring the war to a speedy close. A long war would ruin them, even if they won, and they probably hope to force an immediate conclusion either in France or England—as they had thought to do in Spain—by a mixture of frightfulness and the encouragement of internal dissensions. Whether or not they use gas is likely to be a purely practical question—whether gas bombs would do as much damage as equal weights of other bombs. => MASKS!

[1] Lord Halifax denied any knowledge of its use though it had been reported by American and British Red Cross, and the Italians had declared its passage through the Suez Canal.

Probably gas will only be a secondary factor in the early raids, and above all in that first unheralded raid on which so much will depend. An army with complete control of the air, fighting against virtually unarmed troops—as the Italians in Ethiopia—can fly their aeroplanes at whatever level they like, and spray gas or drop gas bombs where they will. In this way it is effective for protecting the flanks of armies, or dispersing groups of soldiers, or destroying non-combatants behind the lines. But dropping gas bombs from a great height, scattered over an urban area, is a "hit-or-miss" method. On a warm day the gas rises rapidly and may do little harm.[1]

The little evidence which we have suggests that weight for weight the gas bomb inflicts little or no more casualties than high explosives dropped in badly built and congested areas. The material damage done by gas is obviously negligible compared with heavy explosive bombs.[2] The weather conditions are of no importance in connection with high explosives, and it is doubtful whether Herr Hitler will be able to choose his day for the first mass attack with an eye solely to the weather. If gas is used, it will be chiefly for its moral effect—for this mustard gas is also useful—and as an additional

[1] In 1928 some eleven tons of phosgene exploded in Hamburg. Although it was entirely unforeseen it only caused eleven deaths and a few hundred casualties. It was a warm day, and although most windows were open the gas rose.

[2] Gas bombs are far cheaper, weight for weight, than high explosive bombs, but the economic factor is not important with Fascist Powers.

"frightfulness" subsidiary to the real bombing and destruction of a large congested working-class area. Combined with high explosives on a cold, still, foggy day, the gas bombs would certainly add to any tendency to panic, and would increase enormously the difficulties of salvage work.

For this reason gas masks are an essential feature of modern life in Fascist-dominated Europe, but the real questions which should be agitating English minds is the probable effect of a mass attack on east London, on the Euston to King's Cross railway termini, and, for a day raid, on the City and east central area. It will be made regardless of expense. In Spain both Italians and Germans have been very cautious. Some of the Germans who crashed had written instructions not to risk their experimental machines. To be killed raiding Valencia would be something of an anticlimax, but "bomb London and die" would appeal to the heart of any young Nazi. We must also expect some of the pilots to go on and use machine-guns on the great arterial roads, or bomb the western and southern railway stations and lines, though this probably means certain death.

England, unfortunately, has not woken up to the fact that the world has gone savage. Carefully screened by their Government and their Press from the real course of events abroad, most Englishmen are still living in a completely false sense of security. Once war has begun the veneer of civilization disappears very rapidly, but the great danger is that the war will be lost in the first few days. All

the fiddling methods of A.R.P. house protection can be dismissed as irrelevant. There are two ways of meeting the danger of mass attack by high-explosive bombs—combined or not with other forms of incendiary and gas—aimed against population centres by pilots who do not mind taking an even chance of being killed. These two ways are either protecting part of your population *in situ* by getting it safely underground, or by dispersing most of your population over the countryside, *before* the raids begin. A combination of both is essential, and will be considered in the next two chapters.

WRONG! IMPROVISED TABLE SHELTERS WORK IN EVEN WRECKED HOMES!!!

CHAPTER II

(MORRISON SHELTER CONCEPT!)

PROTECTION IN DANGEROUS AREAS

If the general premises in the last chapter are correct, we may expect German raiders to concentrate their attacks on certain industrial areas, which will, for the most part, contain badly built workmen's houses surrounding factories. They may also aim at some closely tenanted office areas, if they come over London during the daytime. They are likely to make high explosives the basis of their bombardment, though they may use incendiary and gas bombs simultaneously, or after a short interval. All experience suggests that, except with very modern buildings of the concrete-and-steel-frame

type, the bulk of the casualties will come from falling houses and masonry.

There would be no great difficulty in scheduling some areas as extremely dangerous, and round them zones in which the danger would gradually decrease. Over most of England the likelihood of being bombed is, of course, infinitesimal. In spite of this, careful preparations are being made in remote villages, preparations far more effective than in parts which ought to be considered as natural targets. This probably does little harm, when it is only a question of drilling the inhabitants of Clovelly, but it helps to give a sense of unreality about the business. The first and real duty of villages is to consider how many refugees they can take.

The danger areas only cover a small part of the map, but they include the houses of a considerable proportion of our population. Two general policies suggest themselves—evacuation, which will be considered in the next chapter, and shelters in the area itself. The making of the houses LIE! themselves safe from air attack is, of course, impossible. No amount of structural alteration of an ordinary brick building can make much difference to the effect of high explosives, and the preparation of "gas-proof rooms" or the shoring-up of cellars is equivalent to advising people to stay in their houses in the hope that the commonest form of bomb will not drop anywhere near them. House protection means very little except in the comparatively well-to-do parts of the great cities, in suburbia, or in the new council

IN DOOR SHELTERS? LIES!! IN DOOR TABLES!

system much of which is deep enough to be perfectly safe against the heaviest bomb. It is possible that the ultimate solution lies in the really deep shelter, using our great knowledge and experience in mining. It has been pointed out by Mr. Wintringham that it only costs a few shillings to get a ton of coal out and to the surface of the earth, yet that provides standing-room for a person. The argument is not quite as simple as all that. The chief expense in all mining operations is the sinking of shafts, and not the tunnelling. People have got to be got under cover in a hurry, but the London tubes, with their well-known stations, could be used, and the refuge area at the tube level or less could be immensely increased.[1]

The question has been considered, and it is one of the many points upon which the A.R.P. authorities do not seem to have made up their minds. It was first announced that tubes would not be used, but subsequently that the position would be reconsidered. If it was known that electricity would be cut off from the rails at the sounding of the warning sirens, the tubes could undoubtedly accommodate large numbers during a succession of raids. The weakest points about the "tubes" as refuges are their narrow entrances, designed for checking tickets rather than for rapid transit, and the very limited area which they serve. If we mark off London into zones of greatest danger, only a small part of the population threatened is in reach of the deeper

[1] During the last war about 100,000 people were accustomed to make for the tubes, and remain there during air raids.

The political question did not arise. There was a clear alignment against Germany, and the pro-German elements in the population kept very quiet until the crisis was over. A mere alarm provides no evidence on this point. Political troubles, if they were to occur, would be consequent on heavy destruction and loss of life, and to the discovery of inefficiency and class bias in the arrangements.

Our stock-taking, then, after the crisis is not reassuring. The voluntary system works fairly well in regard to the evacuation of children, because of the attitude of English parents and the high quality of our professional teachers. It fails badly in the provision of salvage services. Our transport system is still untested, but it showed signs of breaking down under the mild strain to which it was subjected. We are left equally uncertain as to the effect of a bombardment upon the nerves of the town populations. They took the preliminaries of a war without much concern, and the mass hysteria which afflicted the House of Commons, on September 28th, did not communicate itself to the people generally. There was something of a rush amongst the comfortable classes to get themselves and their families out of London, but this had no special repercussions, though it would have added greatly to the difficulties of the real evacuation by road and rail if it had actually been carried out. On the whole it would seem that, even after the tightening-up induced by a serious crisis, our Air Raid Precautions still remain hopelessly amateur and incomplete, and are still adversely affected by a bias towards the safety and well-being of the wealthier rather than the poorer inhabitants of London. ← HORSESHIT!

PRECAUTIONS ARE AIMED AT THE POOR!

PART III

BRITAIN'S AIR STRENGTH

BY

LT.-COMMDR. R. FLETCHER, M.P.

CHAPTER I

OUR NEEDS IN AIR DEFENCE

FOR centuries Great Britain has been able to play a major part in European History, to engage in Europe's major wars and to win through. So long as the Navy held command of the seas, our island went untouched by an invader.

The coming of the air weapon has changed all that. Either we must succeed in organizing international law to such an extent that air forces can be dissolved, leaving order to be maintained by an International Air Police Force or, if we wish to retain immunity from attack and destruction, we must, with our friends, control the air above our island as we have controlled the seas around it.

This country is peculiarly vulnerable from the air. It is a small island; its vitally important industrial and administrative centres concentrated in a few areas, and its capital, and nearly a quarter of the population, lying close to the Continent, clearly marked by the Thames running through its centre.

The air forces employed on a limited scale in

Spain, Abyssinia and China have sufficed to show the devastating effect of high explosive used in air attacks. To inflict damage on London, Birmingham, Manchester, Newcastle, so serious as to render us helpless, for some time at least, is a task well within the compass of an Air Force of the size possessed by any great Power of to-day, unless confronted by an effective defence.

Effective defence includes anti-aircraft artillery, balloon barrages, and A.R.P., as well as fighter aircraft; but our main defence from air attack must remain the strength of our own Air Force to oppose raiding squadrons sent against us and to answer raid with raid.

We can only measure the strength and adequacy of our Air Force in the same way as we have always measured the strength of our Navy; by comparing it with the Forces it may have to meet. It is difficult to ascertain the effective strength of any country's air force. Figures and facts are kept secret; and, out of such as are published, we have to sift the figures of "first-line" strength, of immediately available reserve machines, of other reserves, and of training and civil aircraft; as well as numbers of trained pilots, state of equipment, preparedness, etc. etc.

We are only concerned with machines here in which connection the most reliable figures to which I can refer you are those recently published in the *News Chronicle* in an article by Pierre Cot, who, as Air Minister in the French Popular Front Government, would have Intelligence figures at his disposal. M. Cot says that the front-line air strength of the European Powers is as follows:

Russia	4,000	Gt. Britain	2,000
Germany	3,500	Italy	2,000
France	2,500	Poland	550
Czechoslovakia	550		

Behind these first-line machines each country has a reserve of immediately available machines, largest, probably, in the case of the dictatorship Powers, which began rearming earliest. Germany and Russia, for instance, may well dispose of reserves of over 50 per cent of their first-line figures. Italy may not be so well found but she is in a better position than France or ourselves, whose air rearmament has been later and slower. The air armaments of the Great Powers, first line and effective reserve machines inclusive, may be estimated as follows:

Russia	6,200 to 6,500
Germany	5,200 to 5,500
Italy	2,300 to 2,600
France	2,200 to 2,500
Gt. Britain	2,300 to 2,600

It must, however, be noted that much of the British force is spread out along our Imperial lines of communications, and we cannot rely on more than about 1,900 or 2,100 machines for Home Defence or what is sometimes called the Metropolitan Air Force.

The available data are so unreliable that I should not like to guess at the production, actual and potential, of any other Powers than this country, Germany and possibly France. But I should say that by the time this book is published, Germany will have an actual production of almost 600

machines a month, this country about 400, and France less than 300.

These figures, if approximately correct and which I have put down only after careful sifting of evidence, reveal a very serious situation for this country—remember we are only 250–300 miles from the Rhine, which Lord Baldwin called " our frontier ".

An essential fact to bear in mind when considering questions of aircraft production and air rearmament is that we must expect a 50 per cent wastage of first-line strength per month, in actual warfare, as a very minimum. Some experts say it will be nearer 100 per cent. Our production potential per month then must be not less than half of our front-line strength for war machines only. There are trainer and other aircraft needed as well.

We cannot comfortably face the world with less than an equal strength in first-line aircraft—" parity" as it is called—with any Power within striking distance of our shores. To achieve and maintain such parity was the aim of Lord Baldwin's Government. Looking at the figures I have set out above, you will realize at once that we need a first-line strength of not less than 3,000 planes *now*, in our Home Defence Force; and, since other Powers will be carrying on whilst we are making a supreme effort to catch up, we cannot contemplate, under present conditions, attaining parity short of the 5,000 front-line strength mark. The potential production we have to aim at is, therefore, not less than 2,000–2,500 monthly, or over 25,000 aircraft a year.

That is, I believe, roughly the arithmetic, and the

logic, which inspired the *Sunday Times* to say that the aim of Sir Kingsley Wood's recently reformed Air Ministry, is a potential production of 25,000 per annum, to be reached in two years, and an actual production of half that, which will be needed to reach parity and maintain it.

Note that this means two and a half times our present actual and at least five times our present potential production.[1]

Of course, the figures I have used are necessarily approximate since I have no Intelligence Service to give me precise information; but I am satisfied that they are sufficiently accurate for our purposes here and they illustrate the magnitude of the task and the urgency of the race to achieve security in the air.

From 1931 onwards there were repeated Government warnings that failure to achieve a measure of general disarmament would necessitate an expansion of our defences. No effective plans had, however, been prepared for such an expansion, and when expansion became a necessity the Air

[1] General Veuillemin's Report to the French Government on his recent visit to the German Air Force was as follows; " that Germany had a production of 800 machines per month; a potential production of 2,000 per month; was concentrating, since July, on the production of four types; a new Dornier heavy bomber, powered by four Daimler Benz 1,100 h.p. engines, with a bomb load of about 2 tons (nearly 4,500 lb.) and a speed of 350 m.p.h.; a medium bomber of less formidable performance but greater range; a single-seat fixed-gun fighter, the new Messerscmidt 98, capable of well over 400 m.p.h. and mounting a cannon as well as machine guns, and a new heavy fighter (two-seat) of the type advocated earlier in this book, with a speed of over 360 miles per hour and mounting two swivelling cannon in addition to machine guns. Production of the older types has been stopped and is now concentrated on these four very formidable types, the first and last of which, I should say, are in advance of anything we have. This information serves to underline the danger in which we are, so long as international tension continues."

Ministry was found to be with no list of requirements prepared; there was no emergency programme on paper covering aircraft, equipment, armament, etc. Nor was there in existence any survey of our industrial resources for meeting an expansion programme. The Air Ministry should have known what it wanted and how to get it. It knew neither.

Nor was our small existing Air Force up to date or efficient as regards *matériel.* We had not even a first-rate, if small, nucleus from which to expand, in spite of millions spent on research at Farnborough and elsewhere. Certain aircraft firms had enjoyed a monopoly of orders without any corresponding obligation to keep up to date technically and in design. The Royal Air Force was equipped with obsolescent types; no designs for modern types or plans to produce them existed. When expansion was decided upon in grim earnest this country was anything up to seven years behind the latest practice as regards monoplane design, stressed skin construction, blind-flying instruments, variable pitch propellers, the retractable undercarriage, etc. etc. Ideas adopted from other countries were hastily incorporated in designs, and aircraft were, it was stated, ordered off the drawing board without any prototype being built. It was in this way we are told that we got the Fairey Battle. There being no prototype, resulted in many and various modifications, each entailing some delay in production. The first orders given for the Battle were for a design which provided no accommodation for the navigator.

In a word, expansion caught the Air Ministry napping, and the attempt to expand, side by side

with getting up to date technically, resulted in confusion and muddle so that no expansion programme —and they succeeded each other rapidly—was ever punctually or completely carried out. Here is the brief history of them.

In 1934 the Government announced an expansion programme providing for 1,304 first-line aircraft by July 1939.

In May 1935, Mr. Baldwin announced that he had been misled about German air strength, that she had already achieved parity in first-line strength, and had outstripped us as regards production potential. Thereafter the 1934 expansion programme was amended to produce 1,500 first-line aircraft by March 1937.

The Abyssinian crisis resulted in another amendment of the programme in February 1936, to provide for the Air Force being equipped with 1,750 completely new machines by March 1939. This was an admission that the Air Force was largely equipped with out-of-date aircraft.

The programme was amended for the fourth time in May 1938 to provide 2,370 first-line aircraft by March 1940. Germany *already* has some 1,000 more front-line machines than this!

(N.B.—These figures all apply to what is called the Metropolitan Air Force, i.e., Home Defence.)

The failure to fulfil the first three programmes should be considered in the light of the following pledge, the " parity pledge ", given by Lord Baldwin when Prime Minister:

" Any Government of this country—a National

Government more than any—and this Government—will see to it that in air strength and in air power this country shall no longer be in a position inferior to any country within striking distance of our shores."

(Mr. Baldwin, H. of C., March 8th, 1934.)

Lord Baldwin's second thoughts followed over a year later:

"It is always difficult to know what parity is or from what angle it is envisaged . . . *for our purpose, for the parity of the three nations*, we have taken a figure of round about 1,500 *first-line aircraft*."

(Mr. Baldwin, H. of C., May 22nd, 1935.)

N.B.—The italics are mine and the passage so emphasized establishes the failure of the Government to appreciate or to plan for the situation confronting them.

It will be convenient, in view of what follows, to amplify here the expression "ordering off the drawing board". Prototype, i.e. trial, machines used to be produced rather slowly and were first tested at Martlesham before being sent to various squadrons which reported on them.

At one period of the expansion schemes the Air Ministry announced that as an emergency measure construction of prototypes had been temporarily abandoned and that machines were being ordered "off the drawing board".

Now that production shows signs of improving,

into the air. When production does begin the aircraft delivered will be obsolescent.

The position can be summarized as follows: the Air Ministry's policy of restricted monopoly is hampering the development of a strong, healthy Aircraft Industry. In consequence the production potential of the Industry is neither being fully developed nor utilized.

With the best will in the world, the privileged firms cannot give the country the aircraft production needed.

The monopoly policy has resulted in stagnation in design and equipment and a lag in technical ability. To meet the urgent need of an increase in production potential, the Shadow Factory scheme has been devised to buttress up a faulty system instead of scrapping it, as should have been done. Meanwhile capable firms outside the Ring are not allowed to pull their weight and are excluded from the Supplies Committee and Industrial Panel on which the Ring firms are represented. Nor will the Government agree to create a Ministry of Supply to clear up the muddle, re-organize the system and get production going on a scale which will give us numerical parity, at least, with Germany. Side by side with this melancholy record of inefficiency we find Air Ministry officials retiring to become directors of Approved Firms, a practice which, in the circumstances, is to be deeply deplored.

What are the results of all this? We have Hurricanes and Spitfires designed 1934 and flown at the Air Review in 1936: we shall still be making and

using these in 1940. We have a Shadow Scheme mooted nearly four years ago which has just produced its first aircraft! We have a "Ring" industry, a sub-contracting system, a Shadow industry, and now a Nuffield factory. The whole thing is a muddle.

I turn to the third partner in Aircraft production—organized labour.

CHAPTER VIII

LABOUR AND THE AIRCRAFT INDUSTRY

It is idle to talk of a shortage of skilled labour existing while the production potential of the aircraft industry is not, for the reasons set forth above, being anything like fully utilized. It will be time for such talk when the Air Ministry and the aircraft industry have so organized production as to ensure the fullest results from the skilled labour available. Many instances can be adduced of aircraft firms not working to capacity and paying off men, and of Unions connected with the industry paying large sums in unemployment benefit to their members.

The Trade Unions concerned are:

National Council of Aircraft Workers.
Vehicle Builders.
Ship Constructors and Shipwrights.

Boilermakers.
Woodworkers.
Plumbers.
Foundry Workers.
Coppersmiths.
Woodcutting Machinists.
Brass and Metal Mechanics.
Patternmakers.
Musical Instrument Workers.
Amalgamated Engineering Union.

No approach was made by the Government to these Unions until March 1938, although the Government White Paper of February 1936 mentioned the matter.

The Amalgamated Engineering Union in its journal of May 1938 complains that it:

> "has been placed in a false position. It has been made to appear that we are obstructive on the question of available skilled labour. The contrary is the fact. The available resources of skilled labour are not being properly utilized. There is unemployment among our neighbours. It increased last month by 669. There are thousands of skilled craftsmen on short time in the railway engineering shops whose services could be utilized if production was properly planned. It is creating difficulties to put to the Union in such circumstances proposals for the dilution of skilled labour. There is maldistribution as between one part of the country and another and

as between engineering establishments. The plant and equipment of the engineering industry are not being fully utilized in priority of armaments production, and still no inconsiderable part of the products of the armament industry continue to be shipped overseas. These are some, but not all, of the considerations which determine the attitude of the Union towards the Government's request for co-operation. The Union's insistence on them does not betoken a refusal to help re-armament. By insisting on these aspects the Union is discharging a national service."

Labour complains that with skilled labour available at Union rates and on Union conditions enployers have repeatedly tried to introduce unskilled and semi-skilled men at lower rates. Inevitably strikes and stoppages have followed. The Unions cannot in justice to their members make concessions regarding wage rates, dilution, hours, conditions, if employers attempt to dilute skilled labour while skilled men are unemployed, to introduce non-Union labour and to lower conditions of labour.

There being a shortage of skilled technical men in the industry contractors endeavour to attract such men away from other firms or from the firm whose type they have been given a contract to construct. Nor do men so recruited settle down easily into a good team while the Aircraft Industry has little to show in the way of scientific management of labour.

Skilled labour is an all important factor in aircraft

would be required to hold two months' stocks of all materials, etc., and to prepare a standardized system of storekeeping. On going into war-time production the parent firm of a group would cease production in detail and become the control of the group, sending selected men to the subsidiary firms with knowledge of the production of the component allocated to that firm, and issuing jigs, tools, templates and materials as necessary, for the work issued to each firm.

Such an organization would enable a chain of planned production to function without delay and to a determined time-table and volume of production.

CONCLUSION

SPACE does not permit me to point the morals of the facts and figures I have set down. Let me say that those facts and figures are given in all good faith and I have endeavoured in every way to have them verified and checked.

To my mind they tell a story of incompetence, waste, inefficiency and muddle, for which the Prime Ministers concerned bear, of course, the responsibility, while the blame must be divided between successive Air Ministers and the personnel of the Air Ministry.

Worst of all, self-seeking and profit-seeking have been put before national interests.

I will not enlarge upon this theme because I am reading my proofs while the Czechoslovak crisis is at its height and it is no moment for recrimination. I prefer to say only that Sir Kingsley Wood is, for what my opinion is worth, an able and devoted public servant with a first-rate record as an administrator.

I wish him, and the team he has gathered round him, every success. They can do with everyone's good wishes, for in the words of our American cousins, they have quite an assignment.

It is written of Nelson, that he once went into action exclaiming " victory or Westminster Abbey ". The House of Lords having now become a refuge for our melancholy succession of unsuccessful Air Ministers, Sir Kingsley may be grimly reflecting while he works, that it is " parity or a peerage " for him.

(END OF BOOK)

PENGUIN BOOKS LIMITED
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Nuclear Weapons

Home Office and
Scottish Home and
Health Department

Home Office
Scottish Home and Health Department

First published 1956
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EXTRACTS

Nuclear Weapons

Preface

1. Information obtained from the study of the results of British and American trials of nuclear weapons of different types and power has rendered obsolete some of the information in the Manual of Civil Defence Vol I Pamphlet No I "Nuclear Weapons". This booklet reviews the effects of nuclear detonations in the light of this information and also presents the latest considerations on the control of radiological exposure. Chapter 10 on 'Hazards to Food, Water, Crops and Livestock' similarly incorporates current knowledge. The booklet is intended primarily for use by persons who are involved in home defence planning, but it may be of interest to others.
2. The booklet describes a wide range of nuclear weapon effects. In cross references in the text the first number denotes the chapter and the second the number of the paragraph in that chapter.

Contents

1.10 The more familiar units of energy (eg the kilowatt hour) are too small to express the vast quantities of energy released in the detonation of a nuclear bomb. Two units are commonly used; the kiloton (KT) unit equivalent to 1,000 tons of TNT, and the megaton (MT) unit equivalent to the energy released by the detonation of 1,000,000 tons of TNT.

1.14 The temperature of the air in northern temperate latitudes falls gradually with increasing altitude and, at a height of about 35,000 to 40,000 ft, there is a region called the tropopause where it remains constant at about −60°C: above this is the stratosphere. The cloud produced by the detonation of a KT weapon, if it does reach the tropopause, will not penetrate far but will flatten out into the well-known mushroom shape.

1.26 To counter attacks from IRBMs and ICBMs within the time available between launching and impact, it is necessary to detect the weapon, to compute its ballistic path and to fire and detonate as far away as possible from the target a defensive missile which is close enough to its path to destroy it.

Water bursts

1.19 Detonations in shallow water or at such a height that the fireball touches the water surface are termed 'water bursts'. Large quantities of water and, in shallow water, bottom mud will be carried up into the fireball. When the vaporised water in the cloud reaches a high altitude it will condense to rain and bring down with it radioactive fission products, some of which may be gelatinous or dissolved in the rain drops. The fallout pattern on neighbouring land will be less extensive in area but more intensely radioactive than from a ground burst. Wet fallout may be also more difficult to remove, especially from rough or retentive surfaces, than the relatively dry particles which occur in fallout from a ground burst.

1.20 A nuclear weapon may burst in deep water and, apart from the absence of mud, the effects will be similar to those from a surface burst except that a larger amount of the total energy released will be expended in vaporising water, in producing a shock wave through the water and in forming surface waves. Most of the fission products will be trapped in the water near the burst and will diffuse and disperse rapidly.

Air bursts

1.21 An air burst is one in which the weapon is detonated so that the fireball is well clear of the surface beneath it. There will be very few dust particles to which the vaporised fission products can adhere and they will therefore condense to minute particles with such a low speed of fall that they will have been dispersed far and wide by the winds before they reach the ground. No significant fallout hazard will occur from this type of burst except perhaps to the extent that heavy rainfall may carry down some of the fission products from the lower parts of the cloud before it disperses.

1.22 The height and the power of an air burst determine the extent of blast damage at the surface and this in turn depends upon the type of terrain. For a 20 KT weapon the optimum height to produce the heaviest blast damage in residential areas in the United Kingdom is about 1,000 ft: this may be compared with 600 ft, the maximum height for a contaminating burst (see paragraph 1.15 and Table 1). The corresponding figures for a 10 MT weapon are 1.5 miles and 1.36 miles: even these small differences between the optimum heights for damage and contamination become insignificant for weapons of 20 MT and above.

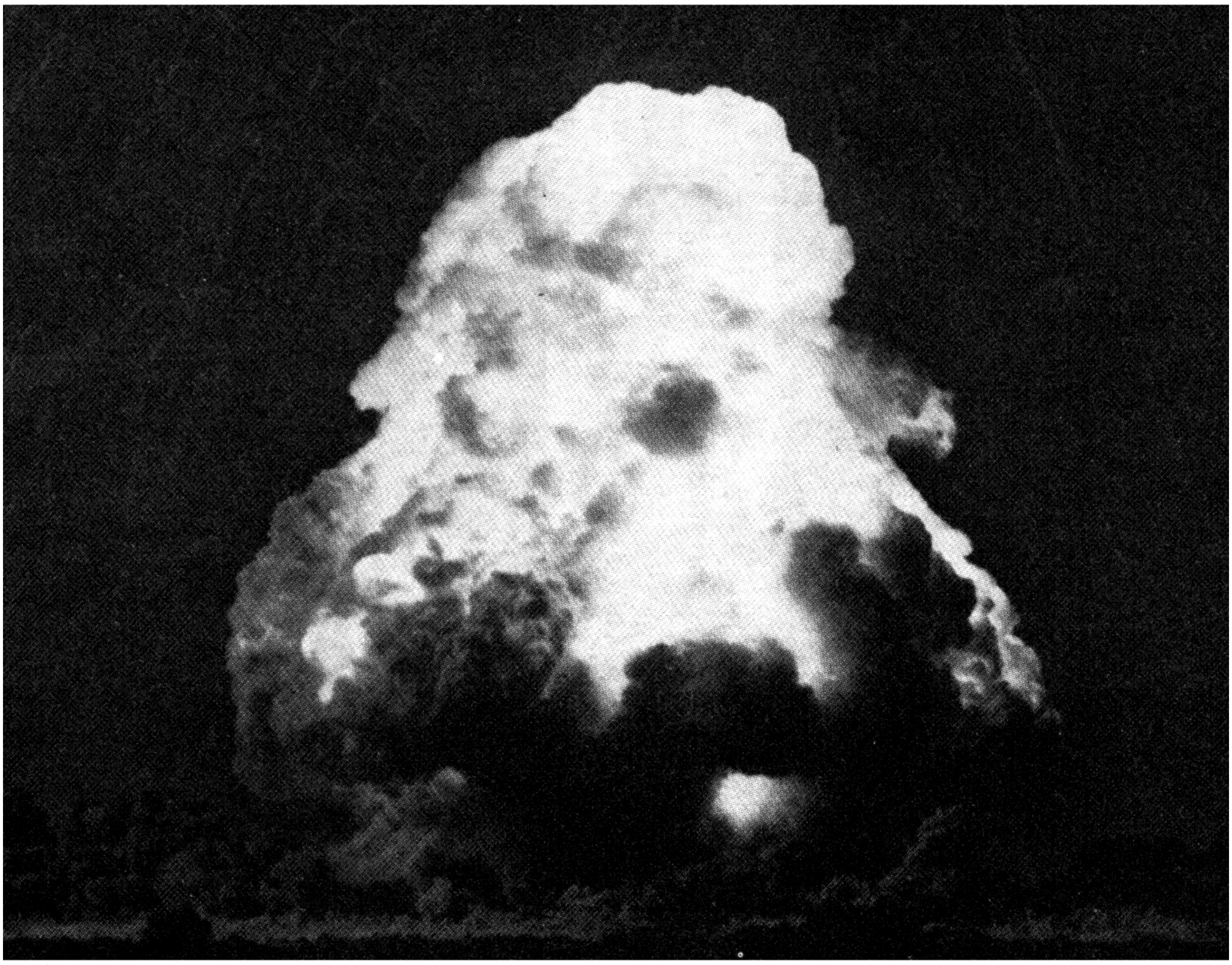


Plate 1 The Fireball

7.2 Initially, the pressure wave is transmitted at a speed considerably greater than that of sound (which is about 1,100 ft per second) but it gradually slows down to this speed. Its speed also depends upon the temperature of the air through which it is transmitted and this factor gives rise to the shock wave. When the front part of the wave reaches a particular point, the air at that point is compressed and heated and the rear portion of the wave is able to move faster through the hot air. Eventually it catches up with the front part. The wave front then becomes steeper and almost vertical as illustrated in Figure 1.

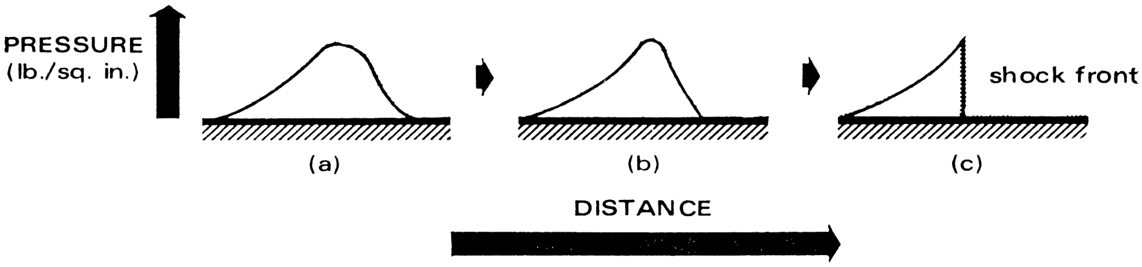


Figure 1 Simplified representation of development of shock front

Any obstacle in its path would experience a sharp blow due to the very sudden rise from atmospheric pressure to the peak pressure of the wave front.

7.3 Shock waves can be reflected from surfaces. When this happens the peak pressure on the surface of the obstacle may be increased by a factor between 2 and 8 depending upon the strength of the original shock wave.

The 'cube root' law (of weapon power)

1.35 The power of a nuclear weapon is defined as the total energy released in detonation. Thus, a 10 MT bomb is 500 times as powerful as a 20 KT bomb and so liberates 500 times as much energy in each of the forms of radiation, blast and fission products. Now the cube root of 500 ($\sqrt[3]{500}$) is nearly 8 and it has been found that the two weapons produce the same peak pressure (blast intensity) at distances from ground zero which differ by a factor of 8. In other words, the peak pressure at, say, 1 mile from the 20 KT detonation will be the same as the peak pressure, at $1 \times \sqrt[3]{500}$ or 8 miles from the 10 MT detonation. Similarly a 1 MT weapon, which is 1,000 times as powerful as a 1 KT weapon will give the same peak pressure at a distance from GZ which is $\sqrt[3]{1{,}000}$ or 10 times greater.

1.36 The structural damage caused at any point by a nuclear detonation is determined largely by the maximum shock pressure at the point in question, but the duration of the shock wave is also significant in the case of larger buildings.

7.9 In buildings with a greater percentage of openings, equalisation of pressure will occur fairly quickly and, because of reflections, the pressure inside may build up until it exceeds the external pressure. This may lead to the building exploding outwards, since buildings are not normally designed to withstand abnormal internal pressures. This explosion effect, which is common in hurricanes and has been observed in atomic tests, could be typical in British houses at the limiting distances for total destruction (Plates 2 to 6).

Table 9 Average ranges of blast damage to typical British houses and blockage of streets. Ground burst nuclear weapons: ranges in miles

Weapon power	20 KT	100 KT	½ MT	1 MT
Damage ring 'A' Houses totally destroyed, streets impassable 11 psi	0–⅜	0–¾	0–1¼	0–1½
Damage ring 'B' Houses irreparably damaged, streets blocked until cleared with mechanical aids 6 psi	⅜–⅝	¾–1	1¼–1¾	1½–2¼
Damage ring 'C' Houses severely to moderately damaged: progress in streets made difficult by debris 1.5 psi	⅝–1⅝	1–2¾	1¾–4½	2¼–5½
Damage ring 'D' Houses lightly damaged, streets open but some glass and tile debris 0.75 psi	1⅝–2½	2¾–4¼	4½–7¼	6–9

Plate 6 The end result (4)

The debris problem

7.16 It will be seen from Table 9 that the problem of access would be a serious one in built-up areas. Even without the radiation hazard, movement of vehicular traffic might be seriously restricted or halted over wide areas until the debris is cleared. Wide streets, streets with front gardens and routes radial to the point of burst are less likely to be blocked to the same degree and might be given priority for clearance.

7.17 Trees are very vulnerable to long duration blast and in many cases fallen trees would block roads at a greater distance from ground zero than any other type of debris. The estimated distances for trees in leaf damaged by ground burst bombs are given in Table 12.

Table 12 Tree damage from ground burst nuclear weapons. (Ranges in miles from ground zero)

Weapon power	20 KT	100 KT	½ MT	1 MT
Trees				
90% blown down	1	1¾	3	3¾
30% blown down	1¼	2¼	3¾	4½
Branch damage	1¾	3	5	6¼

At Hiroshima and Nagasaki, because the bombs were air burst, there was little fallout but the effects of initial radiation were felt (see also paragraph 4.3).

Table 3 Distances (in miles) of initial gamma effects on people exposed, in the open, to a ground or air burst nuclear weapon

Weapon power	20 KT	100 KT	½ MT	1 MT
50 per cent survival (450r)	¾	1	1¼	1½

Table 5 Range of heat effects on people in the open in a clear atmosphere: Radii in miles for ground burst weapons

Weapon power	20 KT	100 KT	½ MT	1 MT
Charring of skin	1	2	4	5
Blistering of skin	1¼	2½	4¾	6¼
Reddening of skin	1¾	3¼	6½	8½

For an air burst, under exceptionally clear conditions, the distances could be about 50% greater.

Personal protection from thermal radiation

5.10 To obtain protection from thermal radiation, one has only to move out of the direct path of the rays from the fireball and any kind of shade will suffice.

Fire protection and precautions

5.12 Primary fires in buildings would result from heat flash through windows and other openings igniting the contents. To reduce the risk, inflammable items should be placed as far as possible out of the direct path of any heat rays that might enter through windows or other openings. If windows and skylights are whitewashed or painted this would keep out about 80 per cent of the heat radiation.

5.13 Because buildings have a considerable shielding effect on one another in a closely built up area the windows of the upper floors are more important than those lower down.

5.14 Blast damage, the scattering of domestic fires, the rupture of gas pipes or short-circuiting of electrical wiring may start secondary fires. The risk of these fires would be reduced by extinguishing boilers and open-fires and by turning off gas and electricity at the mains.

5.16 In the last war fire storms were caused in the old city of Hamburg as a result of heavy incendiary attacks and at Hiroshima but not Nagasaki. A close study of these fire storms and of German cities in which fire storms did not occur revealed several interesting features. A fire storm occurred only in an area of several square miles, heavily built-up with buildings containing plenty of combustible material and where at least every other building in the area had been set alight by incendiary attack.

5.17 It is considered unlikely that an initial density of fires, equivalent to one in every other building, would be started by a nuclear explosion over a British city; studies have shown that due to shielding a much smaller proportion of buildings than this would be exposed to heat flash. Moreover, the buildings in the centres of most British cities are now of fire-resistant construction and more widely spaced than 30–40 years ago. Fire storms after nuclear attack are therefore unlikely in British cities but the possibility would be greatly reduced by the control of small initial and secondary fires.

Table 23 Approximate protective factors in ground floor refuge rooms of typical British housing with timber upper floors and with windows and external doors blocked

Types of housing	Protective factor
Bungalow	5–10
Detached two-storey	15
Semi-detached two-storey 11 inch cavity walls	25–30
Semi-detached two-storey 13½ inch brick walls	40
Terraced two-storey	45
Terraced back-to-back	60
Blocks of flats and offices (see paragraph 9.1) Lower floors	50–500
second floor and above (decreasing)	50–20

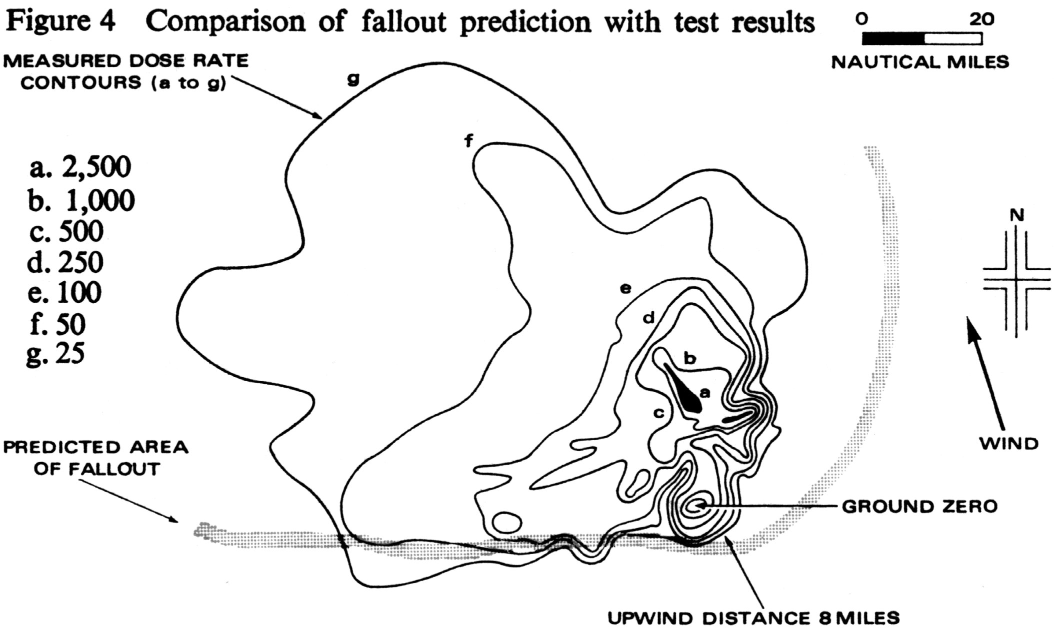
9.20 The amount of fallout retained in the United Kingdom on a clean dry roof with a slope of about 30° (about 1 in 2) or more would be insignificant. If the roof were damp, most of the fallout would be retained until it becomes dry. Rainfall, other than a very light drizzle, would wash fallout off the roof. Consequently the protective factors of prepared refuges in most British houses may be higher than the values given in Table 23.

Table 13 Downwind Contamination. Areas of contours for reference dose-rates at one hour after burst (DR1's) assuming 50% fission yield for ½ MT and larger weapons and 100% for KT weapons

Reference contour dose-rate rph at *one* hour after burst (DR1's) in rph	Areas in square miles for weapon power			
	20 KT	100 KT	½ MT	1 MT
3000	0.2	1.2	10	20
1000	1.3	6.4	45	90
300	5	25	200	300
100	16	82	450	900
30	50	250	1,100	2,000
10	200	1,000	2,250	4,500

8.18 The time between the first arrival of fallout and maximum dose-rate may be anything between one quarter and 4 times that between detonation and the first arrival of fallout: it may be several hours after the maximum dose-rate is reached before fallout ceases.

Figure 4 Comparison of fallout prediction with test results



Basements and trenches

9.21 A substantial increase in protection is obtained in cellars or basements, or in trenches under the floor. For example a trench under a detached two-storied house could give a PF of about 100 and a basement of between 50 and 100, if all the floor was 5 feet below ground level.

9.22 A properly constructed slit trench in the open with 3 feet of earth cover would have a protective factor of 200 or more.

Protection afforded by vehicles

9.23 The protective factors of various types of road transport are very low compared with buildings and would be about 1.5 or slightly more depending upon the size and weight of the vehicle, the height of the seating above ground and on the number of passengers. In passenger trains the protective factor would be equally low, between 3 and 5 depending upon the amount of fallout retained on the coach roof. In ships and boats away from land, protection would be significantly greater owing to the sinking of particles of fallout in water.

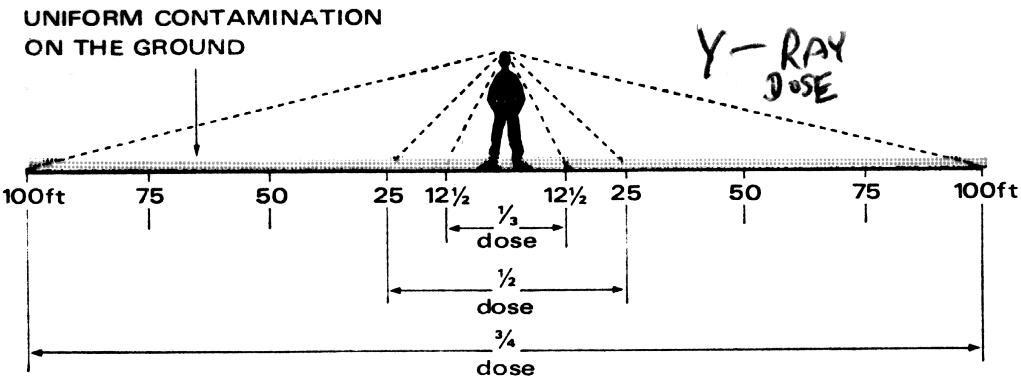


Figure 3 Total dose from fallout—contribution from different distances

Relation between the external radiation hazard and the hazard from breathing or swallowing fallout particles

8.10 When fallout is coming down, or in an area already covered by radioactive fallout, the gamma radiation hazard from the surroundings would be far greater than the hazard from any radioactive dust which might be inhaled or swallowed.

3.4 About 200 isotopes, or different radioactive species, of the atoms of about 35 elements are released in a nuclear fission detonation and their half-lives vary from a fraction of a second to thousands of years. The rate of decay of the mixed fission products is rapid at first but it slows down in time as the shorter-lived isotopes disappear.

$R_t = R_1 . t^{-1.2}$, where R_1 is the nominal dose-rate in rph at 1 hour after burst and R_t is the dose-rate at any later time t hours

Table 2

Time after burst	Dose-rate rph
1 hour	100
1¾ hours	50
7 hours	10
2 days (49 hours)	1
2 weeks	0.1
14 weeks	0.01

Entry of fission products into the human body

10.1 Over and above the main contact hazard described in paragraph 8.6 *et seq*, additional hazards to humans might arise from the consumption of:

a. products derived from animals grazing contaminated pastures or from fish caught in contaminated waters;

b. growing crops superficially contaminated by fallout;

c. superficially contaminated stored food or food in transit; and

d. contaminated water.

Radioactive strontium and iodine

2.17 In order to dispose of some of the myths surrounding radiation hazards, mention is made here of Strontium 90 and related isotopes. The radioactive strontium isotopes found among the fission products of a nuclear detonation are Strontium 89 which has a half-life (see paragraph 3.3) of about 51 days and Strontium 90 which has a half-life of about 28 years. Both of these emit beta particles (see paragraph 6, Appendix I) but no gamma radiation; some Sr90 may accumulate and persist in growing bone for many years, but the beta particles have a very short range and only affect the bone marrow, without reaching the germ cells. Radioactive strontium is therefore not a genetic hazard; nor is radioactive iodine, which tends to accumulate in the thyroid gland in the neck. The predominant form of radioactive iodine has a relatively short half-life of about eight days and could be a hazard, primarily to infants and young children with small thyroid glands.

Eggs, milk and fish

10.19 Eggs, derived from exposed but surviving animals, would not contain enough radioactivity to present a serious ingestion hazard. Most fission products are eliminated via the egg shells. Free-range hens would obviously be at greater risk of dying than those kept under cover. Thyroid damage from the consumption of eggs from apparently healthy poultry can be discounted.

10.20 The main ingestion hazard in the immediate post-attack period is presented by the consumption of milk and milk products, obtained from dairy cattle which have grazed contaminated pastures. Owing to the concentration of radioactive iodine in the animal thyroid and its rapid transfer into the milk, the radioiodine level would reach a maximum after about two to three days. The risk to children would be avoided by the use for, say, three weeks of milk powder, milk substitutes or milk from cows kept under cover and fed on uncontaminated fodder. Contaminated milk could be used to prepare products such as cheese or butter, where normal storage prior to consumption would allow the decay of the short-life iodine isotopes

Fallout on crops

10.16 Radioactive fallout will contaminate large areas of crops and pasture.

Cereals—Wheat, barley etc. Fallout particles lodge mainly in the outer part of the ear. The threshing process and rejection of the husk fraction after milling would remove up to 90 per cent of the original contamination. — Buffalo R2 test data !!!

Root crops—Potatoes, beet etc. The direct contamination hazard to the root is negligible. Rejection of the contaminated tops, washing and/or peeling of the root would give almost complete decontamination.

Surface crops, open leaf—Cabbage, lettuce etc. The rough leaf and open structure of this class of vegetables could result in high retention of fallout particles. These vegetables, which have a low energy value, could be used after rejecting the outer leaves and washing the remainder.

Surface crops, legumes—Peas, beans etc. The pod structure of this class of vegetables provides a natural protective cover, and pod removal ensures almost complete decontamination.

Hard fruits—Apples, pears etc. The acts of washing and peeling provide almost 100 per cent decontamination.

Soft fruits—Plums, blackberries etc. This relatively minor source of food would be difficult to decontaminate.

Greenhouse vegetables—Tomatoes, lettuce etc. Contamination also occurs if the greenhouses are damaged. If the food inside is salvageable, washing in the the case of tomatoes and outer leaf removal and washing of the lettuce ensure adequate decontamination.

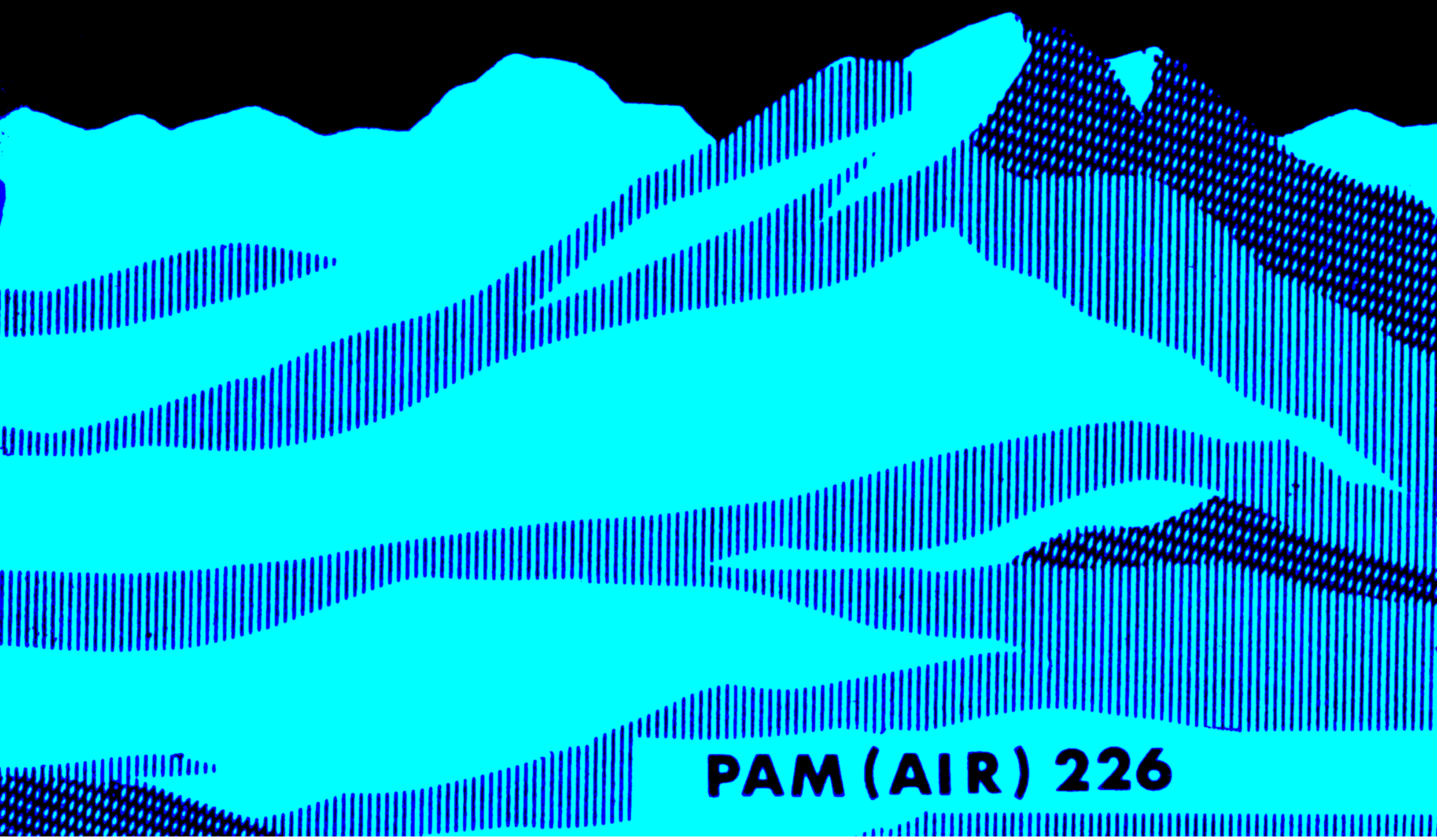
***Table 28** Conversion of relevant British and non-SI units to equivalent values in SI units*

1 micron (micrometre)	one thousandth of 1 millimetre one millionth of 1 metre
1 inch	25.4 millimetres
1 foot	0.305 metres
1 mile	1.609 kilometres
1 square foot	0.093 square metres
1 square mile	2.59 square kilometres
1 foot per second	0.3049 metres/sec
1 mile/h (mph)	1.609 kilometres/h
1 gallon	4.546 dm^3
1 lb force (0.4536 kg force)	4.448 newtons
1 lb per square inch (1 psi)	6895 newtons/sq metre
1 psf	47.9 newtons/sq metre
1 calorie (Btu=252 cal.)	4.187 joules

12. Published information suggests that an unconfined sphere of U-235 metal of about 6½ in. diameter and weighing about 48 kilogrammes would be a critical amount: this would be reduced to about 4½ in. diameter (16 kg) for a U-235 sphere enclosed in a heavy tamper.

RESTRICTED

ARCTIC SURVIVAL



PAM (AIR) 226

RESTRICTED

ARCTIC SURVIVAL

THIS PAMPHLET IS TO BE INCLUDED IN THE EMERGENCY PACKS OF AIRCRAFT OPERATING OVER THE ARCTIC

(Obsolete information on old radio Morse sets is omitted)

PAM (AIR) 226

ISSUED BY
THE AIR MINISTRY (A.D. RESCUE)

1953

Contents

ARCTIC SURVIVAL

INTRODUCTION

1. Survival depends on two, largely psychological, factors: the determination to live and the elimination of fear. Fear is caused through ignorance, in other words *inadequate training*. However, no amount of training or other material aid will suffice without the natural instinct of self-preservation.

2. **The Arctic** The Arctic has been defined geographically as the area north of the Arctic Circle at latitude 66°33°N. From the survival aspect, however, it is more practical to consider the area north of the timber line as Arctic. Along certain Siberian rivers forests grow up to 400 miles north of the Arctic Circle, while along the west shore of the Hudson Bay the tree line is 400 miles south of the Circle. These areas north of the timber line, with a mean annual temperature below 32°F., are known as "barren lands". The region includes the north coasts of Alaska, Canada, Scandinavia, and the U.S.S.R.; the Canadian Arctic Archipelago, Greenland, and the majority of Iceland.

3. **The Sub-Arctic** The sub-arctic is a belt of coniferous vegetation of variable width south of the Arctic Circle. Within it the mean annual temperature is above 32°F. It includes most of Alaska and the interior of Canada, the northern territories of the U.S.S.R., and the most of Scandinavia. The term must be used flexibly.

4. **Other Cold Regions** The principles of arctic survival have to be applied to other mountainous or desolate regions where low temperatures at high altitudes, high winds, a permanent snow covering, or other wintery phenomena prevail at various times. These regions include the Rocky Mountains, the Andes and the Himalayas.

5. **The Arctic Climate** The Arctic is bleak, and in the winter cold, but it is not, as many people think, a region of continual snowstorms, and howling gales where the temperature is always "sixty below". Many Eskimos and quite a few white people live there contentedly. The idea that snow is always falling arises from

the fact that snow is easily stirred by the wind long after it has stopped falling. The two seasons, a long-winter and a short summer, are clearly defined and the temperature varies considerably. In general, the interior areas have the coldest winters and the warmest summer. A temperature of —96°F. has been recorded in Central Siberia. At the other end of the scale, temperatures of 80°F. in the shade are common in many places north of the Arctic Circle. The annual temperature range may be as much as 176°F.; as at Fort Yukon, on the Arctic Circle, where a maximum summer temperature of 100°F. in the shade, and a minimum winter temperature of —76°F., have been recorded. With these high temperatures it is not unusual to find a summer landscape which can be favourably compared with the Orkneys and Shetlands.

PRE-FLIGHT PREPARATION

Prepare for Trouble

6. The best time to start learning what to do when you have been forced down in arctic regions is before the event. The correct preparation involves acquiring a thorough knowledge of:—

(*a*) Cold-weather flying clothing.
(*b*) Safety and survival equipment.
(*c*) Emergency drills and procedures.
(*d*) The principles of survival.

Cold-Weather Flying Clothing

7. Cold-weather flying clothing has been designed to enable aircrew to fly effectively in any type of aircraft, and particular emphasis has been made on freedom of movement. The main essentials are to keep windproof outer materials intact over sufficient inner insulating clothing, and the avoidance of any tight or restrictive clothing. In survival conditions you must depend for warmth, not on fires or fuel stoves, but on your clothing. Your clothing is your first line of defence against low temperatures and high winds. BE PREPARED. Dress for the possible emergency and adjust the temperature of the cockpit accordingly.

8. **Inner Clothing** The principle of correct underclothing is not thickness but insulation. Air in fact forms the main insulation

of all materials used in clothing. The inner flying clothing consists of multiple layers of loosely fitting garments each designed to fit over the clothing immediately beneath it, holding a layer of air between the garments. Your inner clothing will normally consist of:—

(*a*) A string vest made of thick cotton cord, knitted in a wide mesh. The wide mesh holds a layer of air in contact with the body.

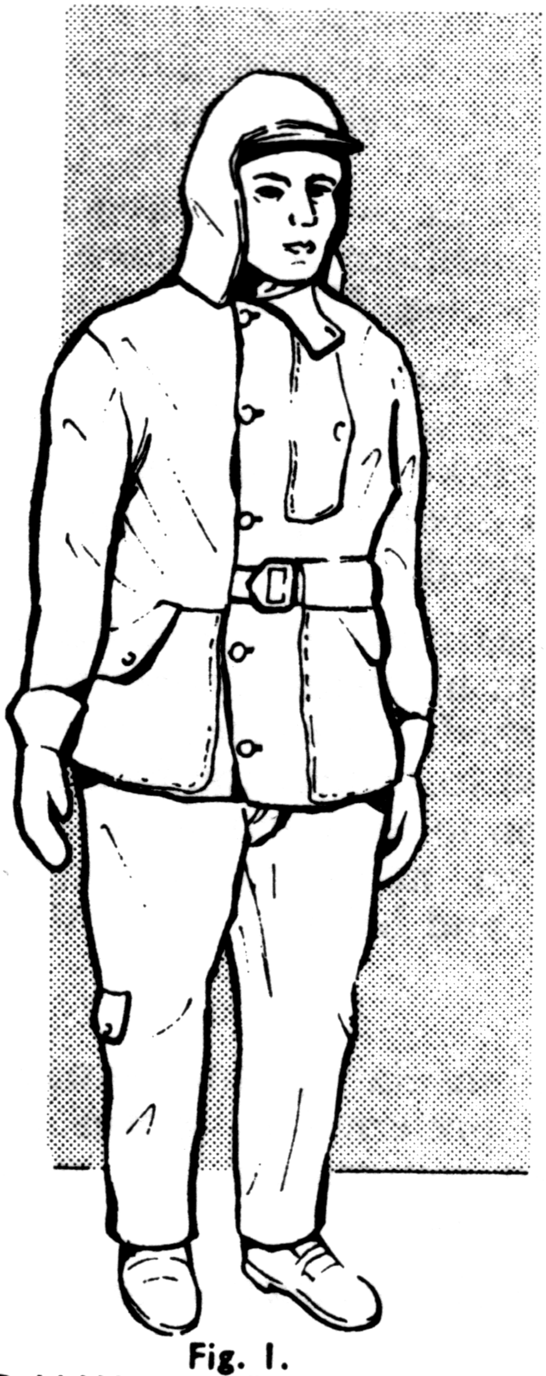


Fig. 1.
Cold Weather Flying Clothing

(*b*) Pyjama-type inner trousers worn under war service flying dress trousers. The looseness of the underpants holds air and allows free circulation and ventilation. In very cold conditions two pairs should be worn.

(*c*) A woollen aircrew shirt with attached collar and buttoning cuffs. A tie should not be worn during flight because it would restrict ventilation at the neck.

(*d*) A long-sleeved, slit-necked, ribbed woollen pullover. A draw cord is provided at the neck opening to help in the control of ventilation.

(*e*) A necksquare made of soft cotton and resembling a large dishcloth. It effectively protects the neck oening and allows some ventilation at the neck. It is designed to protect the face in high wind conditions, and at night, when the face is the only part of the body not protected by the sleeping bag.

9. **Outer Clothing** Outer garments must be windproof and durable. The weave must be close to prevent snow compacting into the material. A certain degree of porosity is necessary to

allow water vapour to escape and evaporate in the cold dry air. You will normally wear:—

(*a*) A cold-weather flying overall which is essentially two garments, trousers and jacket, which have been combined to make an overall as this is more effective in flight conditions. For ground survival the jacket, or inner parka, and the trousers can be separated to allow adequate ventilation. Draw cords are provided at the bottoms of the trousers legs: these are intended for use in survival conditions to help in keeping snow out of the trousers and boot tops. A hood is attached to the jacket and in normal flying conditions it is folded neatly at the back. The face aperture can be closed by a draw cord.

(*b*) A cold-weather cap made of windproof material and lined with woollen fabric. It may be worn alone or under the hood of the flying overall or outer parka. The cap has internally stowed flaps which can be turned down to give protection to the back of the neck, ears, and forehead.

(*c*) An outer parka to be worn in extreme cold over the flying overall. It has both windproof and insulating properties. The collar, to which the hood is attached, is fur-lined. The hood, closed by a draw cord, is designed to protect the face in high wind chill conditions. An extension to the hood, for use in the severest weather, consists of an adjustable wire-stiffened curtain edged with wolverine fur, and helps in preventing the wind reaching the face.

10. **Handwear** Handwear must be insulating and windproof, and must not be tight. Mittens are preferred to gloves as the fingers will give mutual warmth, but mittens are not ideal for aircrew. The handwear assembly consists of:—

(*a*) Long woollen wristlets which give protection to the wrist and the back of the hand.

(*b*) Inner mitts of wool.

(*c*) Outer mitts made of soft leather. The palm of the hand is lined with a wool pile material, and a pad of the same material is sewn on the back. This pad is used for warming the nose or the face in the event of frostbite, and also as a nose wiper.

Pyrotechnics

34. You will have a limited supply of emergency pyrotechnics, and possibly the aircraft signal pistol and cartridges. Fire them only when you are fairly certain that there is a chance of them being seen by the search aircraft. The search aircraft at night, using the Night Service Technique, will fire green cartridges every 5 to 10 minutes. When the survivors see a green light, they should wait for the aircraft to clear the glare and then fire a red pyrotechnic; after a short interval fire a second one. If the search aircraft sees the reds he will turn towards the first one and check his course on the second one, at the same time firing a succession of green lights until he is overhead. The survivors should conserve their pyrotechnics, and only fire a third red signal when the aircraft is almost overhead or is going off course.

SHELTER

35. In the winter you cannot stay in the open and expect to live, unless you are on the move. You must have shelter even if it is only a hole in the snow. Shelter is less important in summer, but it will provide comfort and relaxation under the most ideal conditions. The type of shelter you elect to build will depend on:—

(*a*) What tools are available.

(*b*) What materials are available.

(*c*) What you need shelter from—wind, snow, cold, rain, or insects.

(*d*) How long you expect to remain in that location.

Regardless of the type, the shelter must provide adequate ventilation to prevent carbon monoxide poisoning and to allow moisture to escape.

Selection of Site

36. A summer camp site should not be on low-lying ground, which is likely to be damp, or in areas that might be flooded. Select a spot in cool breeze to keep the insects away, either on top of a ridge, or the shores of a cold lake, or a place that gets an onshore breeze. The lee of boulders and shelving rocks should provide dry camp sites.

37. During winter, protection from the wind is a prime consideration. Avoid the lee of slopes and cliffs where snow may drift heavily and bury your shelter.

38. In mountain camp sites avoid areas which you suspect are subject to avalanches, floods, and rockfalls. Temperature inversions are common in the Arctic so do not camp on a valley floor; it may be several degrees warmer on the slopes.

39. If on sea ice, the site must be on the thickest ice, the biggest floe, and away from thin ice joining two floes where pressure ridges may form.

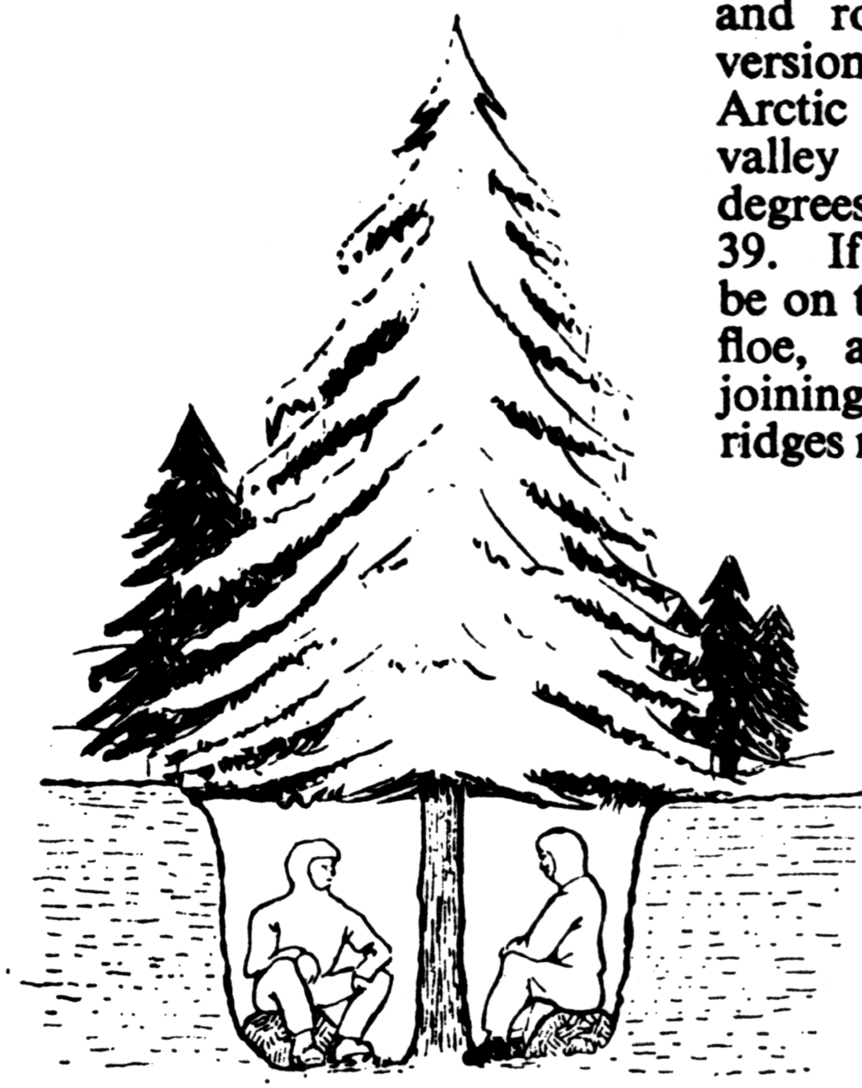


Fig. 4. Natural Hole under a Tree converted into a Shelter

40. With all sites the nearness to fuel and water must be considered. An ideal camp site is seldom found, and a compromise may be necessary. A site which does not give protection from the wind can be protected by a windbreak. Other deficiencies of a camp site may be similarly overcome.

Natural Shelters

41. Caves and overhanging rockshelves will often provide dry shelters. They should be used in the winter only if well insulated, and in summer only if they can be made insect-proof. In timbered country where the snow is deep, spruce trees often provide ready-made shelters. The natural hole under the lower branches will provide a quickly available shelter. The lower branches at snow level will form the roof. (Fig. 4.)

Aeroplane Shelters

42. In the summer the fuselage will make an adequate shelter if it is on safe ground; it is waterproof and can be made insect-proof with parachutes. Is SHOULD NOT be used as a shelter in winter unless it is well insulated. The metal is a good conductor of heat and will quickly dissipate any available heat. In Winter you can make two types of shelters using a wing or tailplane as a roof or support. The first, a snow block shelter, is made by piling up snow blocks to form a windbreak, walled shelter, or snow-house. The second is made by hanging engine covers or a parachute over the wing. The loose ends can be anchored by rocks or piles of snow.

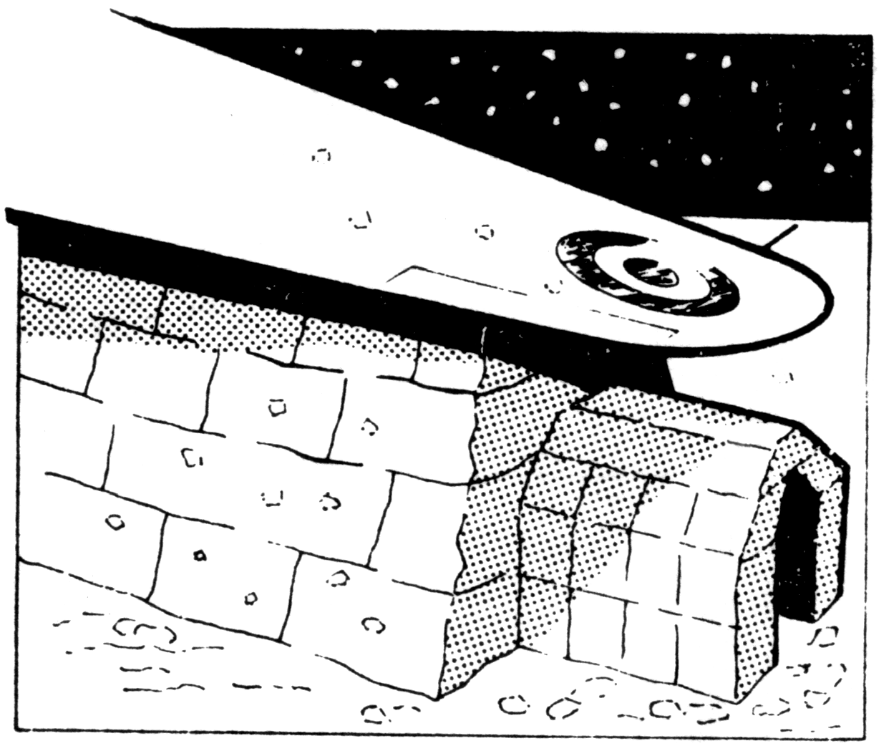


Fig. 5. Wing-Showblock Shelter

Parachute Shelters

43. **Paratepee** An excellent shelter for protection against drizzly weather and insects is made from a parachute canopy. In it you can build a fire, cook, eat, sleep, dress, and make signals—all without going out of doors. You will need ten good poles about 12 to 14 feet long, and half a parachute canopy. The method of construction is shown in the illustrations. The other half of the canopy can be used as additional tenting to provide insulation, should the weather demand it.

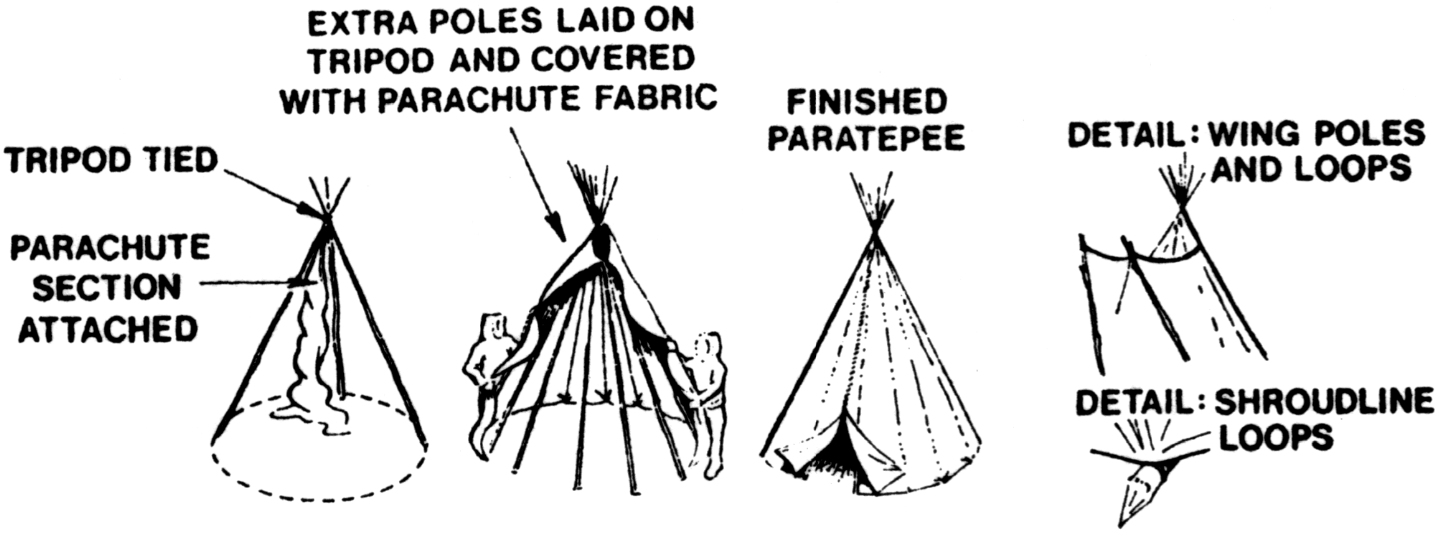


Fig. 6. Construction of Paratepee

44. **Pup Tent** A simple pup tent can be made by placing a rope or pole between two trees or stakes and draping a parachute over it. Stretch the corners down and secure them with stones or pegs.

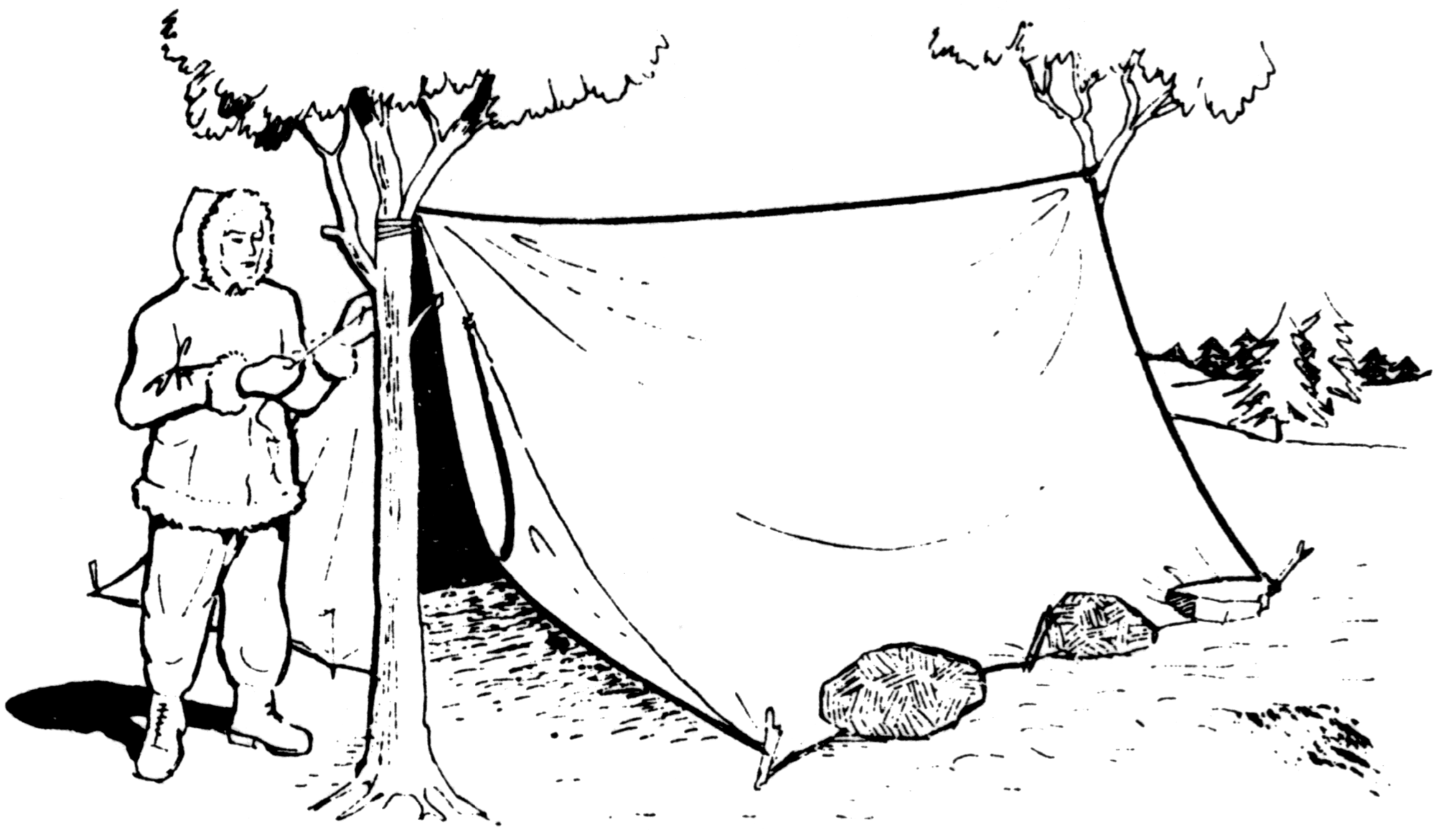


Fig. 7. Pup Tent

45. **Simple Bell Tents** A variety of bell tents can be constructed. Always use the double layer principle to provide adequate insulation.

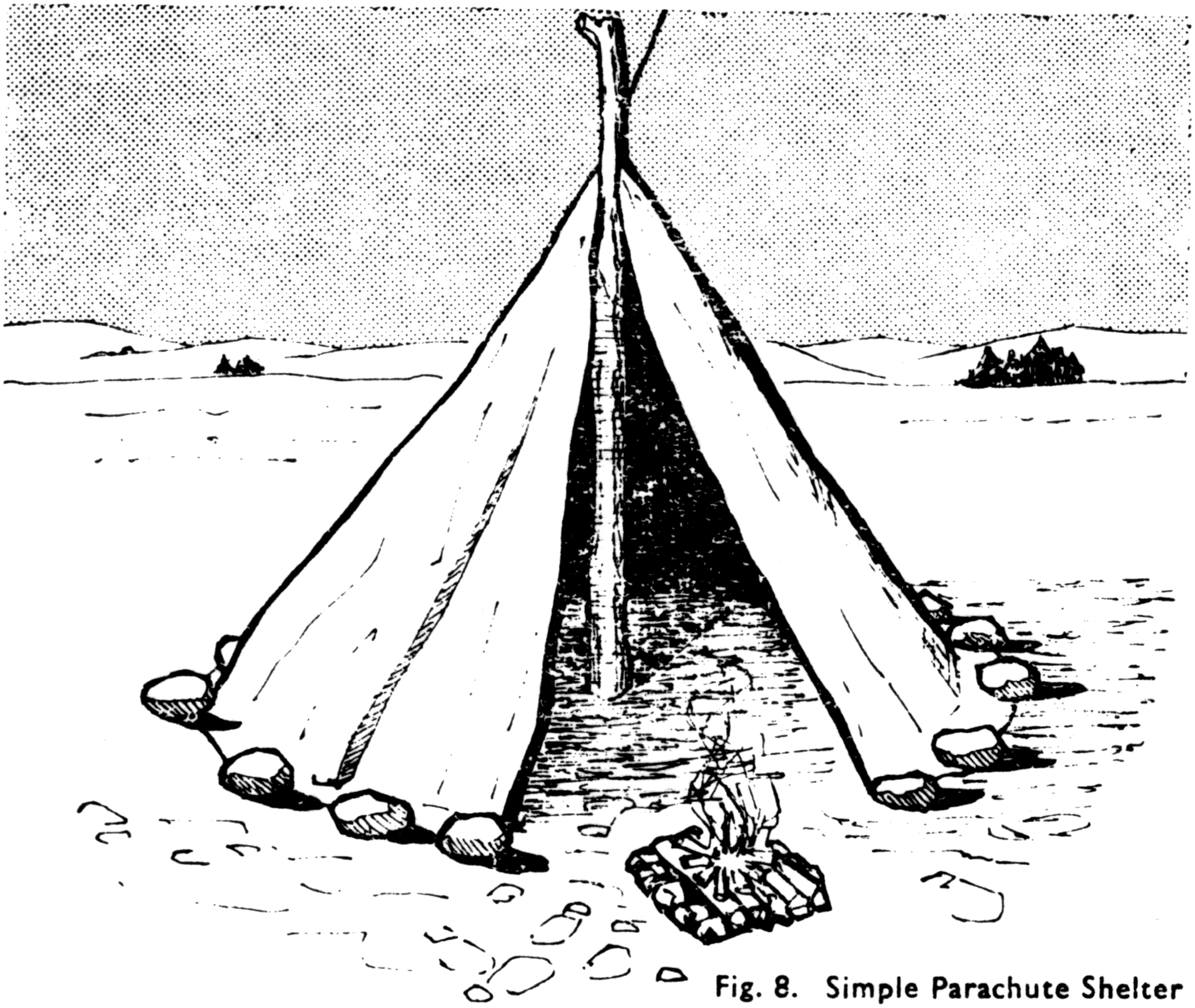


Fig. 8. Simple Parachute Shelter

Fig. 9. Double Bell Tent

46. Willow Shelter Where willows are plentiful this shelter can be made very quickly. The floor area should just accommodate the sleeping bags and the maximum height should just allow the occupants to its up without their heads touching the roof. The tunnel-like construction is shown in Fig. 10. The framework can be covered with several layers of parachute canopy which may be anchored with snow.

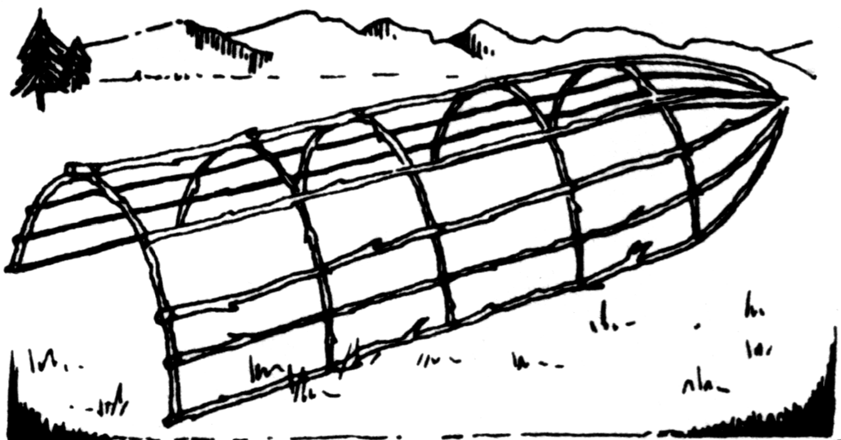
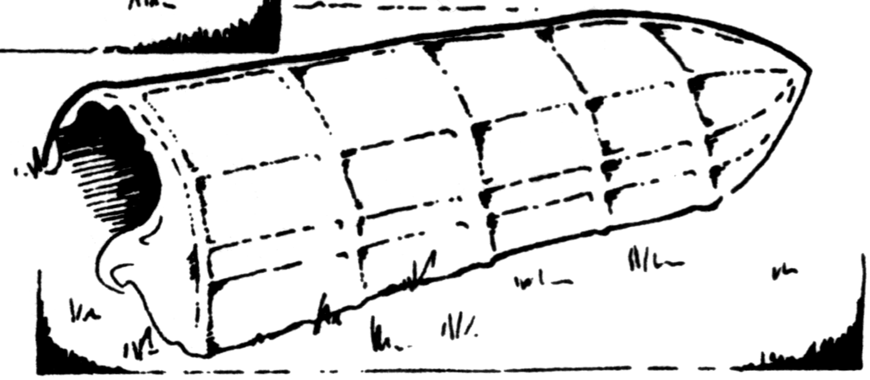


Fig. 10.

Construction of Willow Shelter



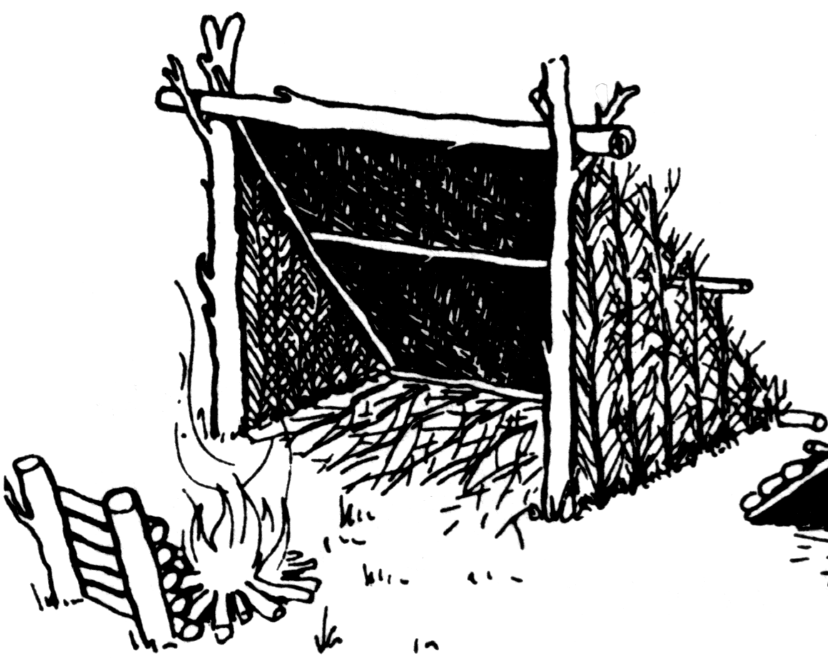
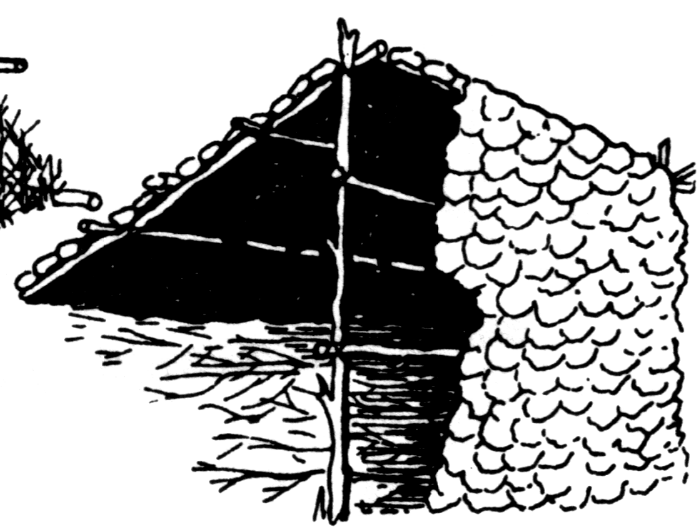


Fig. 11. Lean-to

Fig. 12. Bough Den



Wood Shelters

47. **Lean-to and Bough Shelters** If you are in timbered country and have plenty of wood, the best shelter is a lean-to. A good three-man lean-to is shown in Fig. 11. The roof can be covered by sod blocks, spruce boughs, or any similar materials should be woven in from the top like a tiled roof to prevent rain from entering the shelter. A quickly improvized temporary shelter is a two-sided bough den (Fig. 12); it requires fewer poles and less time to build than a lean-to, but it cannot be waterproofed as efficiently.

Snow Shelters

48. The type of snow shelter you can construct will depend on the quality of the snow. You will have to decide whether or not the snow is suitable for cutting up into snow blocks. The ideal snow for snow block shelters is that upon which a man can walk without breaking through or leaving deeply embedded footprints. The snow must also be tested by pressing a probe into it slowly; if it goes in evenly the snow is ideal for cutting snow blocks. Snow blocks should measure about 18 inches wide by 20 inches long and four to eight inches thick. Blocks of this size should be easy to cut and handle. They will be thick enough to provide good insulation and strength, yet thin enough to allow maximum penetration of the sun's rays. The lighter the interior the warmer it will be and fuel will not have to be used for light. In addition, a light inside a snow block shelter makes a good beacon at night.

49. **Snow Trench** The ideal snow block shelter is the snow trench, which is designed for one man. Start the construction by marking out a rectangular floor area; big enough to accommodate only one sleeping bag. Remove the snow from this area, by cutting out snow blocks, to the full width of the trench and to a depth of four feet. Along the top edges of the sides of the trench, cut an L-shaped step six inches deep and six inches wide; these steps serve as a base for the snow blocks when the trench is roofed. At the end away from the entrance, place two blocks on the steps on each side of the trench and lean them together to start forming an inverted V roof. The two blocks should be offset, so that after the first pair of blocks are joined, it will be necessary to handle only one block at a time. Each end of the roof should be covered with

blocks and an entrance dug through the snow at the down-wind end. If the snow is not four feet deep, the walls can be constructed of snow blocks to the required height.

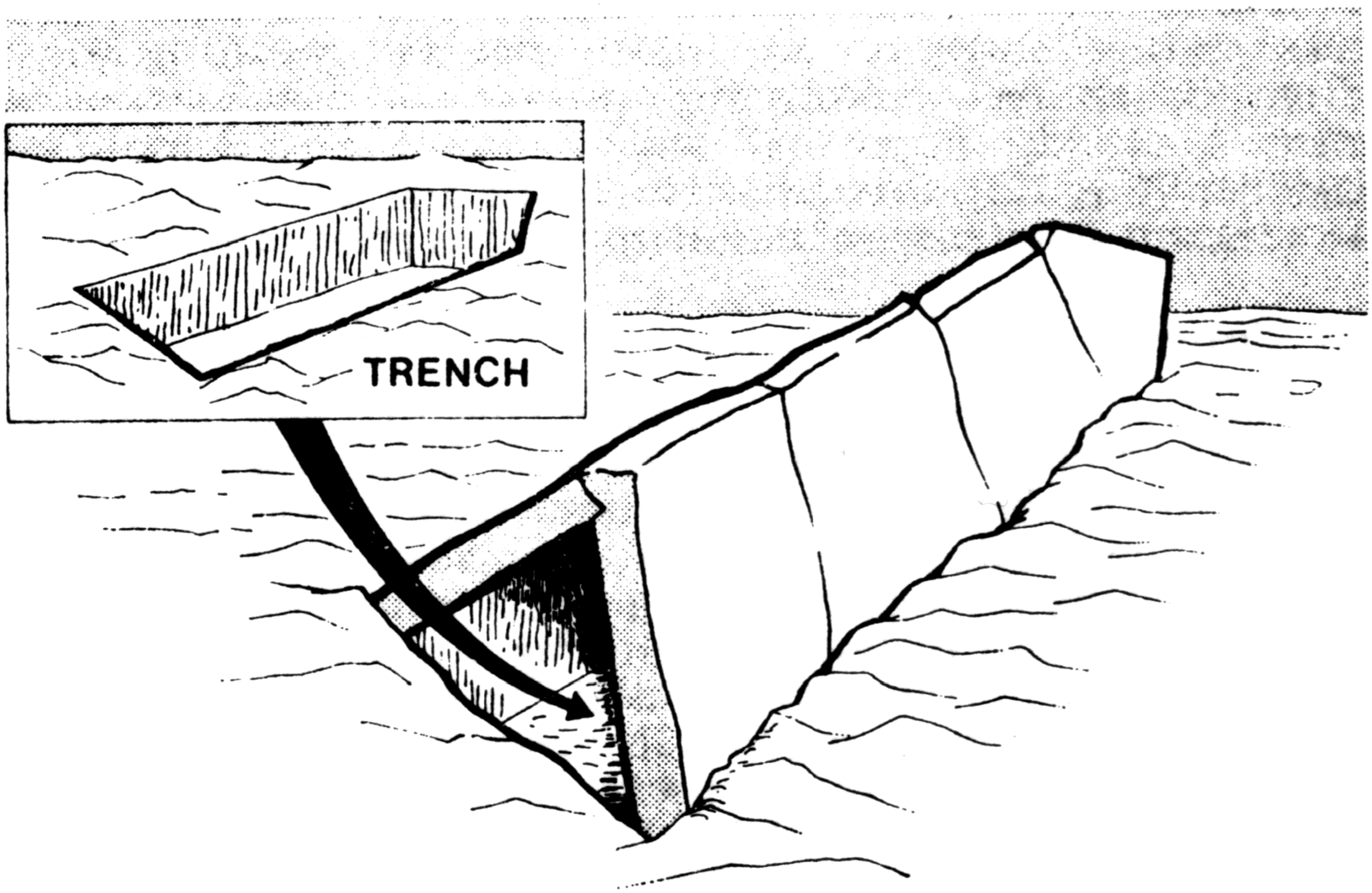


Fig. 13. Construction of Snow Trench

50. **Snow Caves and Snow Holes**

(*a*) A snow cave can be dug wherever snowdrifts of sufficient depth can be found. Caves are difficult to dig without getting wet and are therefore less desirable than a trench-type shelter. The roof of the cave should be arched to allow moisture to run down the walls without dripping. Also, an arched ceiling will not sag readily from the weight of the snow above.

(*b*) An excellent temporary shelter can be constructed by simply digging a hole in the snow and using your parachute canopy as a roof.

51. Big crews should build individual or two-man snow shelters radiating from a central or communal entrance. The entrance can be protected by a circular snow wall and tented with a parachute canopy.

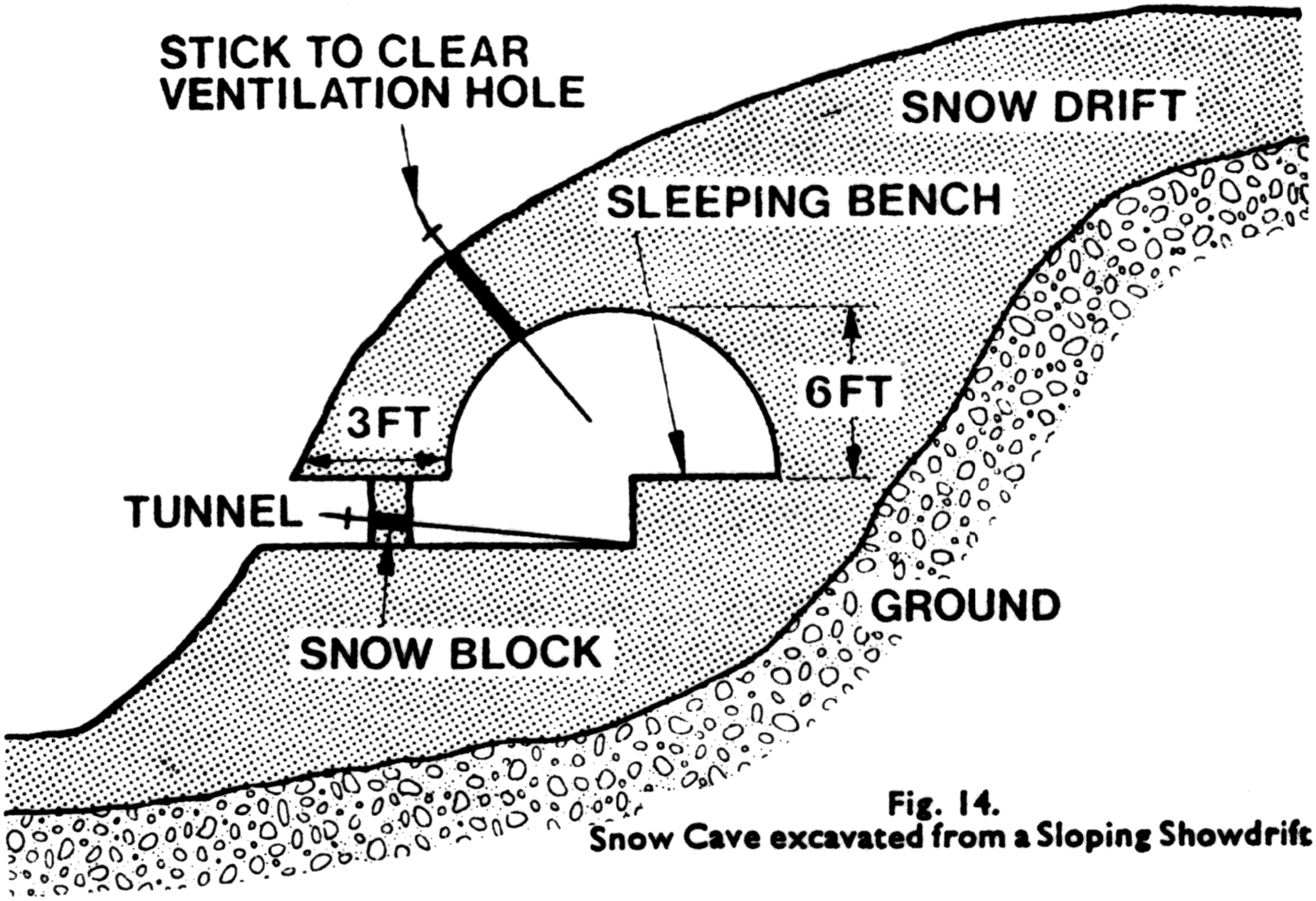


Fig. 14.
Snow Cave excavated from a Sloping Showdrift

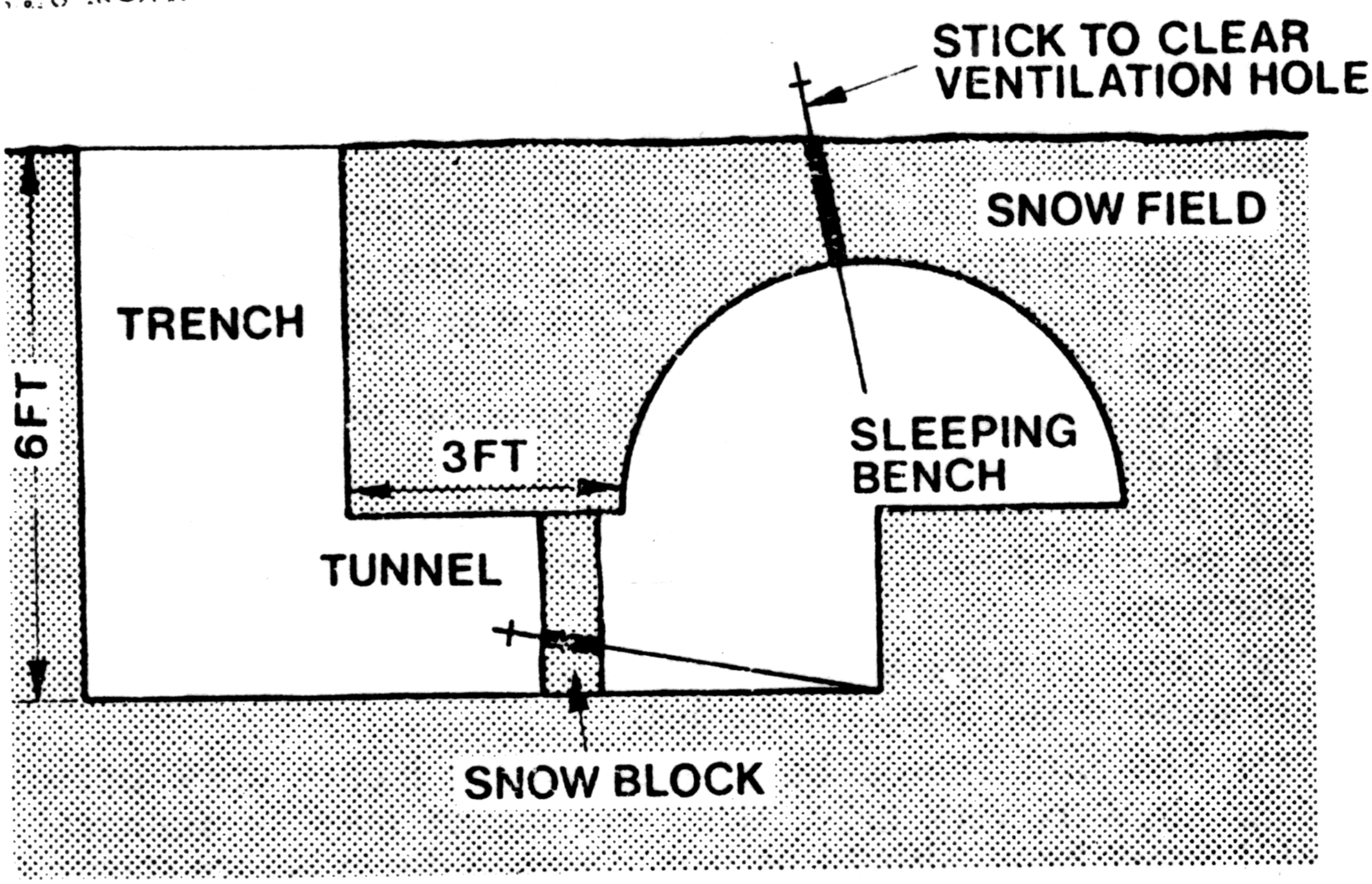


Fig 15. Snow Cave dug from the side of a Trench in a Flat Snowfield

Beds and Bedding

52. In snow shelters beds should be made on a sleeping bench which will raise you into the warmer air of the shelter. In all types of shelters beds should be well insulated from the actual floor of the shelter. Depending on your resources the following make good insulating material:—

(*a*) Parachute canopy, backpad, or seat cushion.
(*b*) Inverted dinghy.
(*c*) Lifejacket.
(*d*) Seat cushions, asbestos, etc., from the aircraft.
(*e*) Ferns, shrubs, lichens, moss, evergreen boughs (particularly spruce tips).

Your insulating can be as thick as time permits; six inches at least is desirable. Rearrange it regularly to prevent packing down.

Practical Hints

53. The following points should not be neglected:—

(*a*) The smaller the shelter the warmer it will be.

(*b*) Adequate ventilation to prevent asphyxiation and carbon monoxide poisoning is of vital importance.

(*c*) Two ventilation holes, one near the top of the shelter and the other at the entrance, must be kept clear. One hole is not sufficient, as the air cannot then circulate.

(*d*) Shovels and tools must be taken into snow shelters, as it may often be necessary to dig a way out if snowfalls or drifting occur.

(*e*) The entrance of each shelter must be clearly marked so that it can be easily found.

(*f*) A mark should be made on the snow above each shelter to show its position and to prevent men from walking over the roof.

(*g*) Drips in snow shelters can be stopped by putting a piece of snow on the source of the drip.

(*h*) The roof should be at least twelve inches thick unless the snow is very hard, when six inches may be sufficient.
(*j*) Snow floors should be well tramped down before starting to build the shelter.

54. During survival you are kept warm by a combination of body heat, insulative clothing, and shelter. However, you will need a fire to prepare hot food and drinks in order to maintain and replenish your body heat. A fire is also necessary for drying clothes, for signalling, and to provide external heat. In extreme cold, however, very little heat can be obtained from a fire unless you get so close that you are liable to scorch your clothing. A fire will increase your morale, particularly during the long dark winter days.

55. Your immedate source of heat for cooking is supplied by the emergency stove in the aircraft survival pack; however, this will not be available should you bale out. Your personal survival pack contains candles, which are most suitable for heating snow shelters, fire-making tablets, and matches. These immediate sources of heat may be supplemented, according to your natural fuel supply, by open fires and improvized stoves.

Fires

56. The main ingredients for a good open fire are a good fire-place, kindling, fuel, and a means of lighting the kindling. To these can be added a little knowledge and a lot of patience.

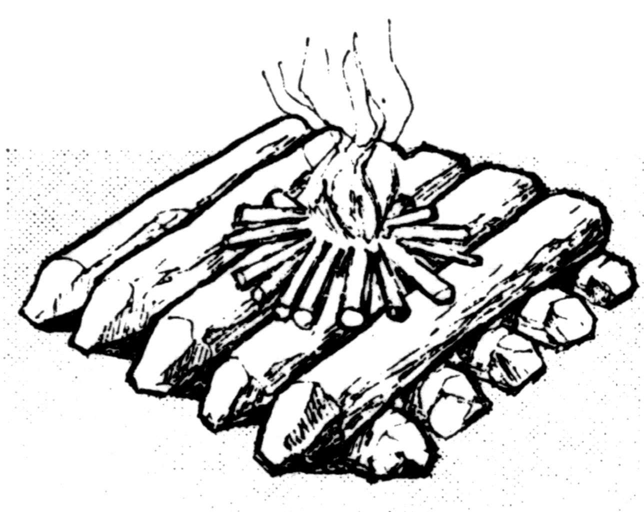


Fig. 16. Log Platform for Fire

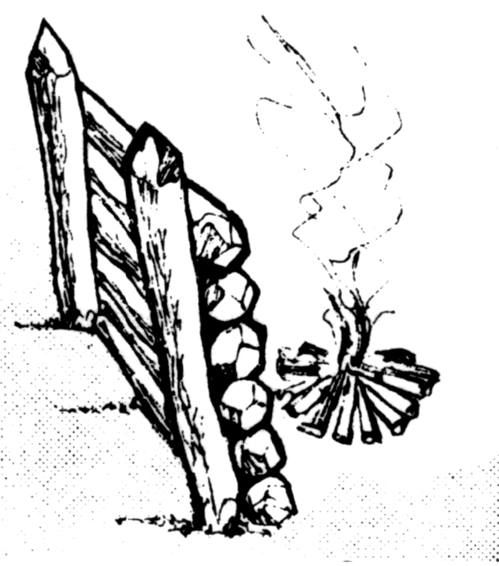


Fig. 17. Log Reflector for Fire

57. **Fireplaces** Prepare the location of your fires carefully. Don't build a fire under a snow-covered tree—snow may fall and put out the fire. Protect domestic fires from the wind, and so save fuel. Build the fires on a firm platform; use green logs, stones, cowlings, or dig down to firm soil. Cooking fires should be walled in by green logs or stones, not only to concentrate the heat but to provide a platform for your cooking pot. Fires for warming shelters should be built against a reflector of rocks or green logs to direct the heat into the shelter.

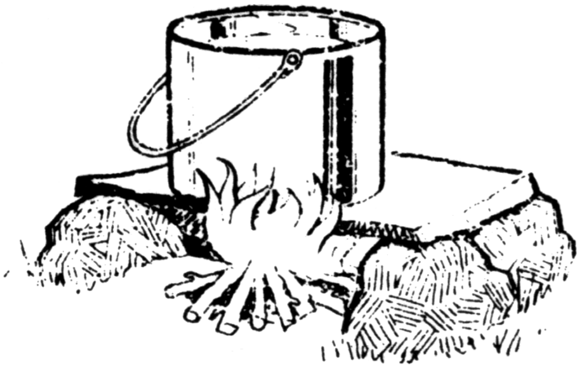


Fig. 18. Cooking Platform

58. **Kindling** You will need some easily inflammable kindling to get a fire going. Pick up kindling whenever you can find it, even if you do not expect to make camp for some hours. Gather birch bark, dry lichens, twigs, resinous shrubs, bits of fat (if not required for food), feathers, tufts of dry grass and sedges against the possibility of a shortage of good kindling at the camp site. Larger twigs can be cut in "feather fashion" if kindling

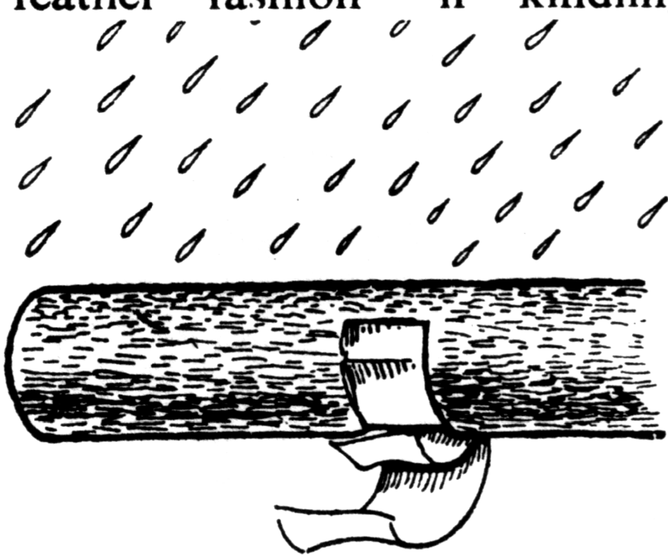


Fig. 19. Birch Bark Under-layers

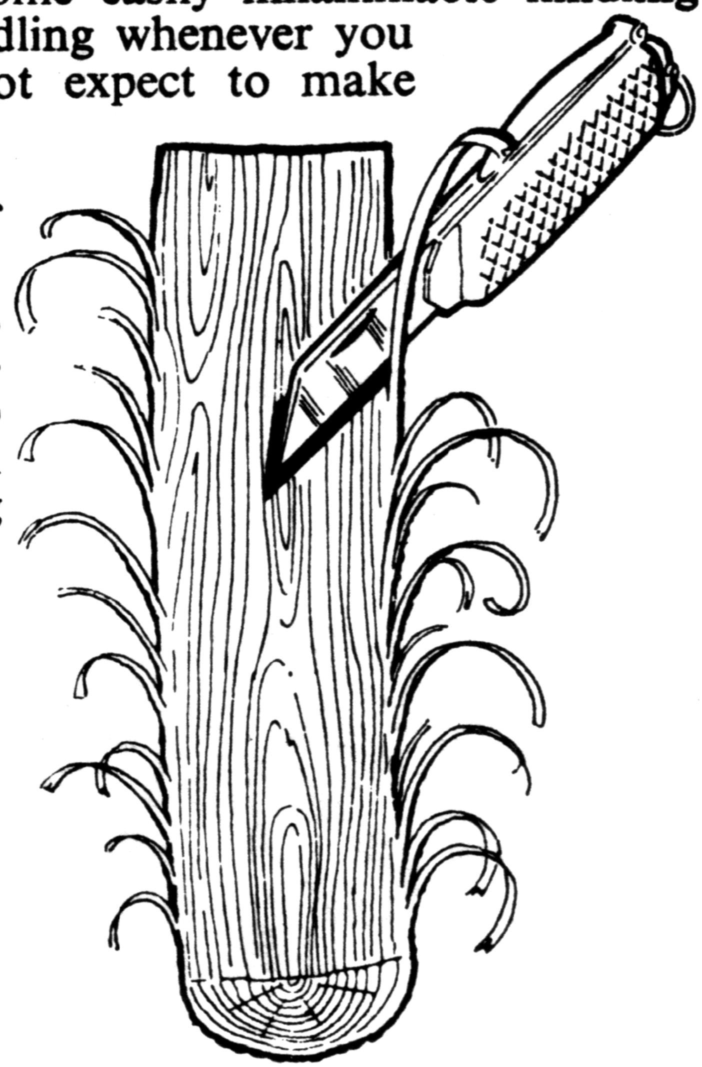


Fig. 20. Feathering Wood for Tinder

is scarce. Paper or rags and twigs soaked in fuel or oil are good artificial kindling.

59. **Natural Fuel**

(*a*) *Wood.* Even in polar regions there are clumps of dwarf willow and birch. Birch is oily and if split fine will burn even if wet. Standing deadwood and dead branches provide your best fuel; the dead trees can be easily pushed over and chopped up. Lying deadwood and driftwood is likely to be frozen or waterlogged and is useless unless dried out. Green timber can be burned on a hot fire.

(*b*) *Coal.* Outcrops may be found occasionally on the surface and coal may be found washed up on beaches.

(*c*) *Animal Fats.* Use animal fats for food rather than fuel. Your will derive more heat from fat you eat than from fat you burn.

(*d*) *Gassiope.* In some barren grounds, where there is no driftwood and little willow or birch, the Eskimos depend almost entirely on this plant for fuel. It is a low, spreading, evergreen plant, with tiny leaves and white bell-shaped flowers. It grows from four to twelve inches high and contains so much resin that it will burn even when green or wet.

(*e*) In treeless areas you can find other natural fuels such as dry grass which can be twisted into bunches, peat dry enough to burn (found at the top of undercut river banks), and dried animal dung. Try anything for fuel, but in small quantities until you are certain of its qualities.

Firelighting

60. Get all your materials together before you try to start the fire. Make sure your kindling and fuel are dry, and have enough fuel on hand to keep the fire going. Arrange a small amount of kindling in a low pyramid, close enough together to allow the flames to lick from one piece to another. Leave a small opening for lighting. Save matches by using a candle to light the fire, or make a faggot of thin dry twigs tied loosely. Apply the lighted candle or faggot to the lower windward side of the kindling, shielding it from the wind as you do so. Use the firemaking tab-

Fig. 21. Laying a Fire

lets only if the tinder is damp. Small pieces of wood or other fuel can be laid gently on the kindling before lighting, or can be added as the kindling begins to burn. Add larger pieces of fuel when the kindling pile is considered large enough to support and ignite them. Don't pack the wood so tight that the draught is shut off. Encourage the fire by blowing gently on it.

61. For a large fire, the sticks in each layer should be parallel to each other and at right angles to the layer below. Space the sticks so that the air can get between them and create a good draught. For a small fire lay the sticks in radial fashion, and as they burn push them into the fire. With this method longer sticks need not be chopped up.

Emergency Fire Lighting

62. The availability of fire-lighting equipment may mean success or failure in a fight for survival. Many people have lost their lives because they have been unable to light a fire to provide warmth or attract attention. Your personal survival kit provides matches, candles, firemaking tablets, and a magnifying glass for this purpose.

63. Firemaking without matches requires bone-dry tinder which will burn very easily. Very dry powdered wood, finely shredded dry bark, cotton, twine, first-aid gauze bandage, fuzzy or wooly material scraped from plants, fine bird's feathers, or bird's nests are most suitable. You can make it burn more easily by adding a few drops of fuel.

64. **Burning Lens** An emergency burning lens may be obtained from binoculars, gunsights, bombsights, or cameras. The lens should be used to focus the sun's rays on the timber.

65. **Flint and Steel** A flint and steel is the easiest and most reliable way of making fire without matches. Your knife and sharpening stone or a piece of hard rock should produce a good spark. Hold the flint as near to the tinder as possible; strike it with a sharp scraping downward motion so that the sparks fall into the centre of the tinder.

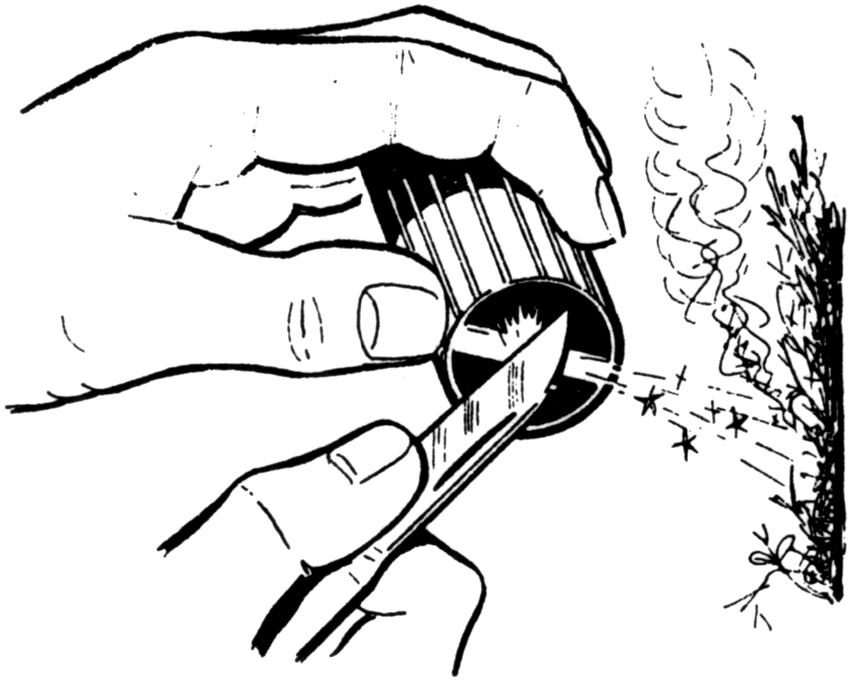


Fig. 22. Lighting a Fire with Flint and Steel

66. **Bow Drill** Another standby is the bow drill. This consists of a bow made from a willow strung with some cord madə from your parachute shroud lines. The drill is a circular shaft of dry wood around which the bow string is wound once. The drill shaft is pointed at one end and round at the other. The round end revolves in a depression made in a piece of wood which is held in one hand. Lubricate this depression. The point of the drill is placed in a notch in another piece of wood, which is filled with tinder. By holding the drill shaft in posi-

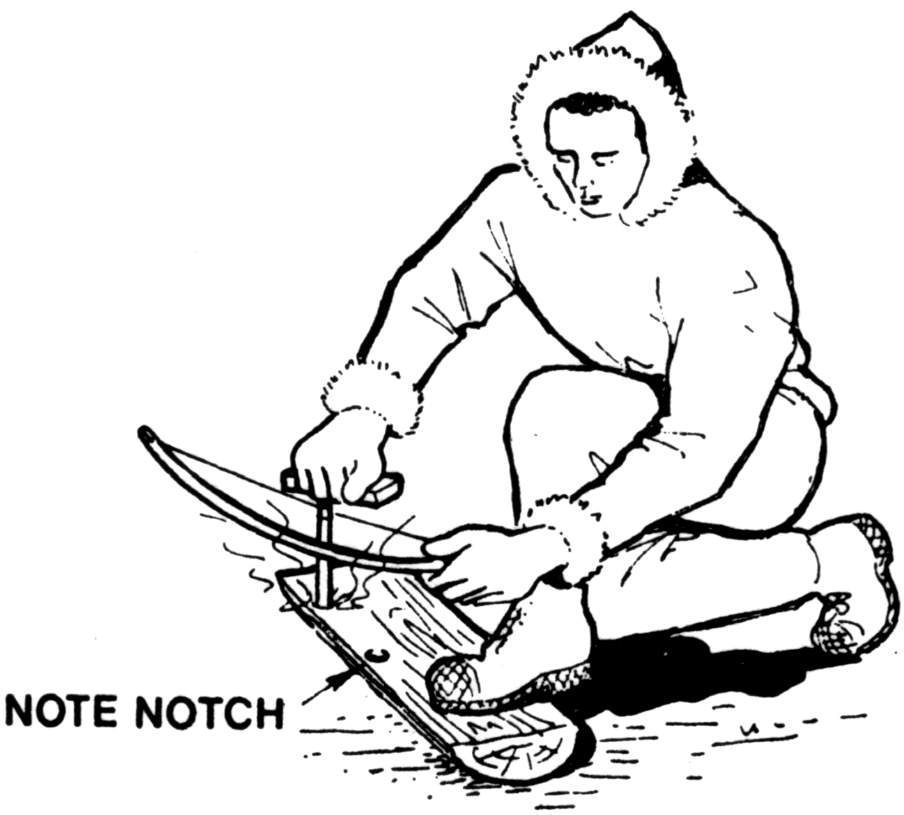


Fig. 23. Bow and Drill Method of Firemaking

tion and moving the bow back and forth in a sawing motion in a horizontal plane, friction is set up and the tinder ignited.

67. **Pyrotechnic** A pyrotechnic may have to be used to light a fire if all other means have failed. Weigh the use of the pyrotechnic as an emergency signal against the need of a fire. The powder extracted from a pyrotechnic will burn so quickly that it will be necessary to mix a slower burning material with it; powdered wood or shredded fabrics are the best mixing materials. The powder from one pyrotechnic will provide sufficient tinder for a number of fires. The unused powder should be kept dry. Above all, **be extremely careful when you are extracting the powder from the pyrotechnic.**

Stockpile

68. Make all your preparations as far ahead as possible, regardless of whether or not you have been located. Stockpile fuel against bad weather or shortages. Stack it where it cannot be lost by drifting snow and protect it from rain. Prepare your kindling at least three fires ahead and store it inside your shelter.

Improvised Stoves

69. Aircraft fuels such as rubber, wax insulation, fuel and oil are more economically burned in improvised stoves. These stoves can be used inside or outside the shelter as required. To burn petrol, place one or two inches of sand or fine gravel in a tin or similar container and saturate it with petrol. Make slots at the top of the can to let the flames and smoke out and punch holes just above the level of the sand to provide a draught. To make the fire burn longer mix some oil with the petrol. If you have no container dig a hole in the ground, fill it with sand or gravel and pour on the fuel. Be careful when lighting; the petrol may explode; protect your face and hands. Lubricating oil, kerosene, or animal fats will not burn directly, but you can use them with a wick arrangement. Make a wick of kapok, asbestos, rope, rag, etc., and support it in the oil with a wire frame. A very simple stove can be made by putting a candle in a ventilated tin can. This will provide all the heat required for a snow shelter. (Figs. 24 and 25.)

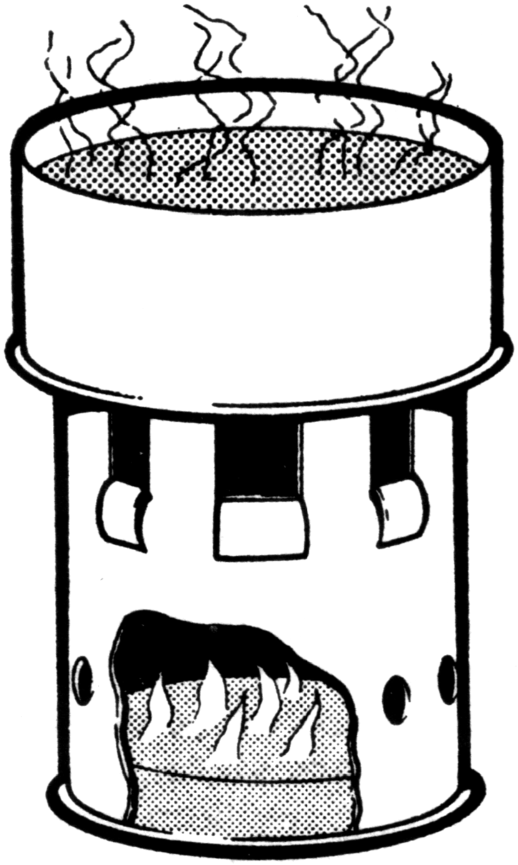


Fig. 24.
Improvised Petrol Stove

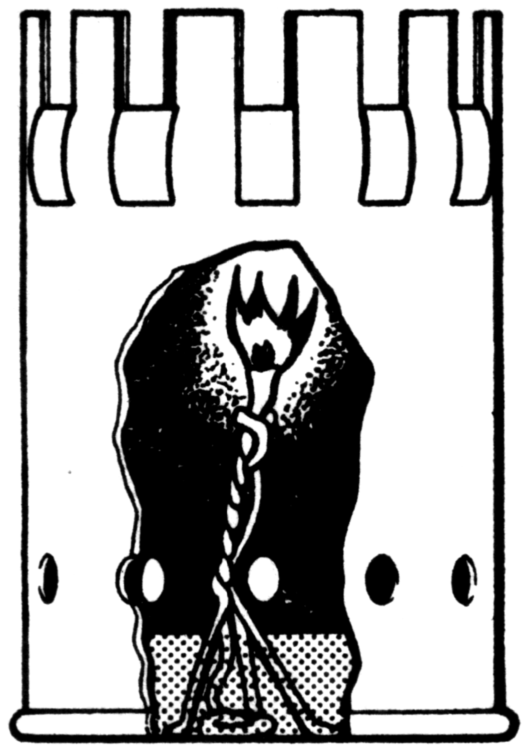


Fig. 25.
Improvised Stove using Wick to burn Oil or Animal Fat

Ventilation

70. The need for proper ventilation cannot be over-emphasized. When open fires or stoves are burned inside shelters, carbon monoxide and other gases will accumulate unless the shelter is ventilated. Also if animal fats or oil are burned, good ventilation will carry away the heavy black smoke. If a vent is made in the lower portion of the shelter—the entrance should be sufficient—and another at the top, cold air will move in through the lower opening, be warmed, and pass out through the top vent. The current of air will carry away the carbon monoxide and soot. Remember that carbon monoxide is heavier than air and a man lying down will be first affected. To retain the maximum amount of heat in a shelter restrict the vent holes when fires are out. *Restrict the temptation to "get up a good fug"*

FOOD

71. Take stock of all your available food. Your emergency food packs and uneaten flying rations are your immediate, and in the barren land probably your only, sources of food. Your

food pack has been designed to provide sustenance for three days' very hard work, five days' active work, or seven days' normal work. The food packs contain their own directions of how they should be used. In extreme cold, two hot meals a day are necessary one for breakfast and the other in the evening. Also, if you have enough, a hot drink at midday is desirable. Avoid drinking two hours before bedding down and remember to urinate immediately before getting into your sleeping bag.

Living Off the Land

72. Contrary to general belief, food is not abundant in the Arctic. All wild life is migratory and, since neither the time nor the position of the crash can be predetermined, there is no point in attempting to take up the involved subject of seasonal game distribution. The game you get in survival will either be there or come there. It means that you should survey the locality, set suitable traps, and wait for the game to come. To get food from the land you will have to do some very determined foraging. Leave a man in the camp at all times as look-out, while the rest of the party searches for food; detail men for fishing or hunting according to their talents. Care should be taken to blaze a trail back to camp. In large aircraft you might be carrying some sort of firearms, but you will normally have to rely on the snares and fishing kits in your survival packs. Additional snares may be made from wire and parachute elastics salvaged from the crash. You will have to learn where to look for, and, in all except plant food, how to catch it. When you find local animal or plant food, eat as much as you want and save your emergency rations. Fat is heat-producing food and very important to your health in the Arctic. Eat a lot of fat only when you can drink at least two pints of water daily. If you have any doubt about the safety of any wild food use the following rule; eat a spoonful and wait eight hours; if there are no ill effects, such as vomiting or diarrhoea, eat a handful and wait another eight hours. If there are still no ill effects, you can eat reasonable quantities safely.

Animal Food

73. Finding animals on the open tundra is not easy, but don't be too quick in deciding that the area is lifeless. Keep on the lookout for any signs of animal life—such as excrement, tracks,

hair, and, in extremely cold weather, "animal smoke" steaming from their bodies. These may put you on the trail of food. Wherever there is one kind of animal there are almost sure to be other forms of life. The animals you may find rnge from lemmings, which are stub-tailed mice, to polar bears. What you catch will depend on your facilities and skill. Small animals such as lemmings, muskrats, hares, woodchucks, squirrels, and snowshoe rabbits, can be caught with sling shots, snares, deadfalls, and other simple traps. The larger animals such as polar and brown bears, caribou, moose, seals, mountain sheep and, wolverine, are difficult to kill. They may be snared or captured by deadfalls and pit traps, but unless they are strangled or stunned they are hard to kill without a gun. Learn to attract animals by kissing the back of your hand vigorously and making a squeaking noise which indicates the presence of a wounded mouse or bird; that should definitely attract some hungry animal. But learn to conceal yourself.

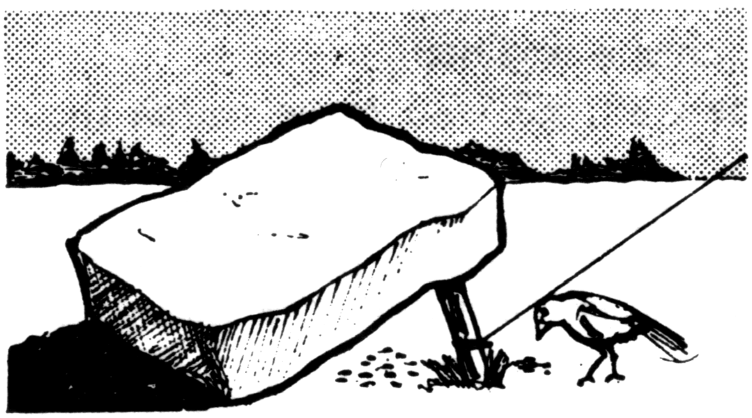


Fig. 26. Simple Deadfall

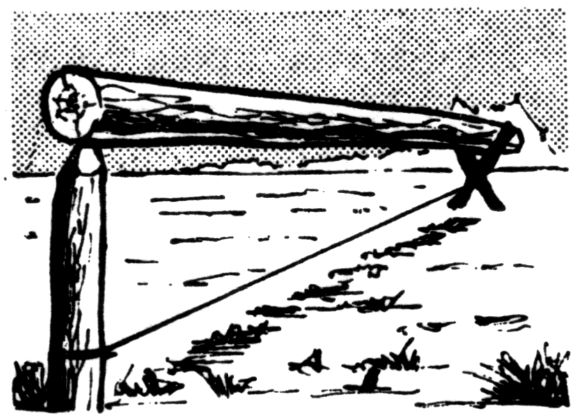


Fig. 27. Tripwire Deadtail

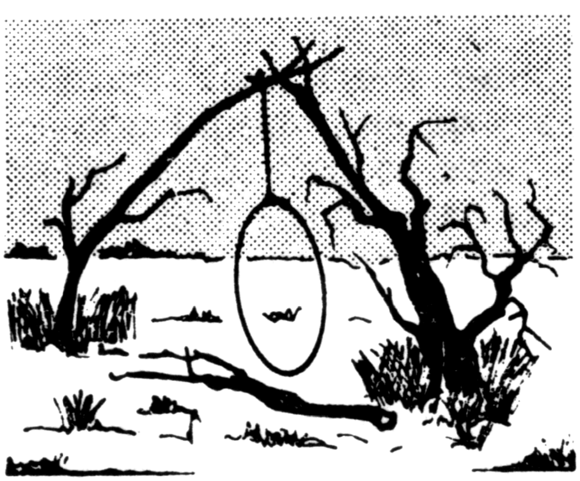
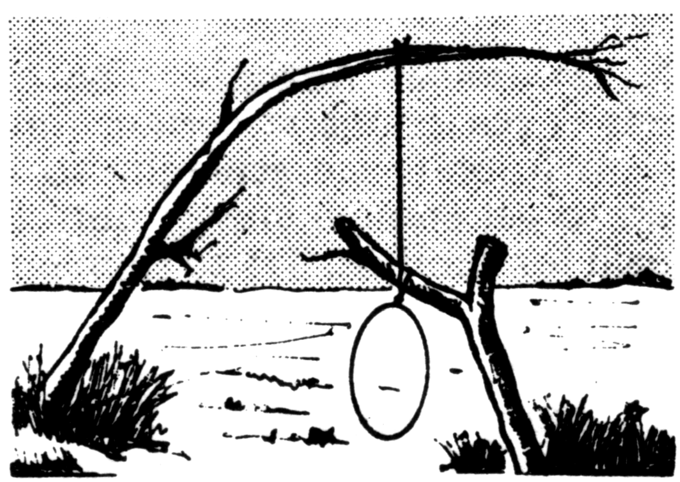


Fig. 28. Simple Snare



29. Trigger Snare

74. **Hunting Hints**

(*a*) Keep the wind in your face. A calm day is not generally windless; make sure of the wind direction.

(*b*) Try to have the sun in your back, especially a rising or setting sun.

(*c*) In timber country move slowly and carefully; don't break any twigs under foot or allow swinging branches to hit your clothing.

(*d*) In hilly and mountainous country big game animals generally watch below them more than above. Keep slightly above the level where the game is most likely to be seen.

(*e*) In mountainous country, cross currents make it less important to keep the wind in your face.

(*f*) Animals are used to rolling stones in the mountains, therefore it is not quite so important to avoid noise.

(*g*) Avoid crispy snow; try to hunt where snow is soft.

(*h*) Don't expose yourself against a skyline.

(*j*) Never stay on the game trail; all wild game watch their back trails.

(*k*) If game is feeding, you can attempt to approach it by stalking in the open. Crawl slowly when all heads are down. Freeze motionless—whatever your position—the instant an animal starts to raise its head.

(*l*) When shooting game aim for the vital areas: behind the ears, in the throat, or behind the foreshoulders. Much game is lost because it is out of range.

75. **Poisonous Animals** The liver of polar bears and bearded seals is poisonous at certain times of the year and should not be eaten. Rabbits are generally so lean and have so little food value that to get enough energy out of them you have to eat a little too much for comfort. Try to supplement your diet with other things.

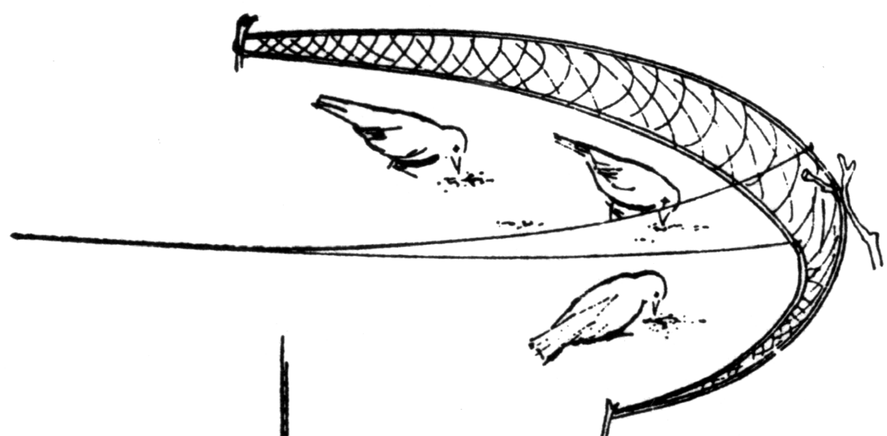
Bird Food

76. Many northern birds nest in colonies which may run to hundreds of thousands of pairs. Near such a colony a man can keep alive—even without a gun. Some Arctic birds are well supplied

with fats—notably ducks, geese and swans. These water birds all go through a two- or three-week flightless period while they are moulting in midsummer. The best known winter birds are the ptarmigan or snow partridge, which is rarely fat; the white owl, which is usually fat and tasty; and the raven, which is tough. All birds are good to eat cooked or raw. Their blood and livers are edible. The feathers can be used for insulation. The entrails and toes make good bait.

77. **Bird Catching** Study bird habits closely. Hunt for birds on their meeting grounds on islands, cliffs, marshes and lakes, on coastal plains, and on flats in interior areas. An improvized slingshot is a good bird catcher. Ptarmigan are very tame and can be killed with a stick or stone. Gulls can be caught with a gorge hook and line; bait the hook and let it float on a piece of wood or stake it out on a beach. Eskimos set a simple noose snare in the nest itself to catch the bird's feet.

Fig. 30.
Bird Trap



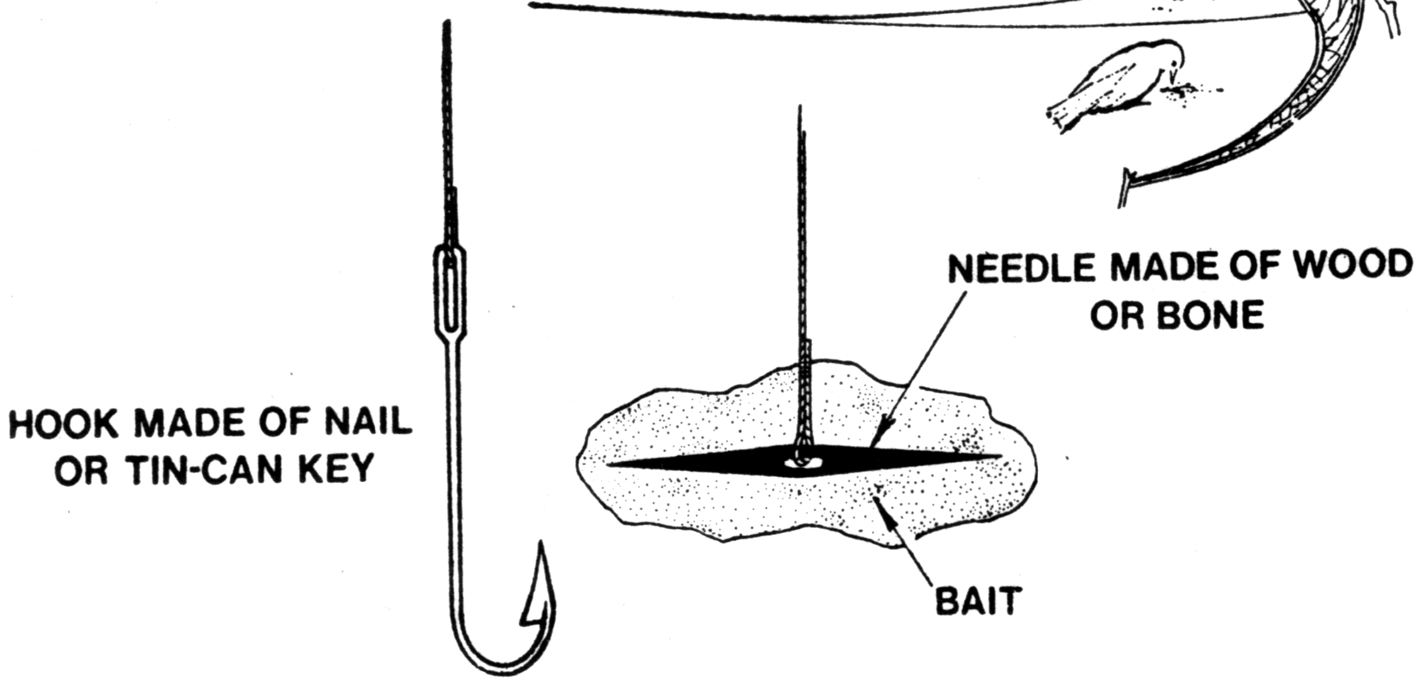


Fig. 31.
Hook for Catching Seagulls

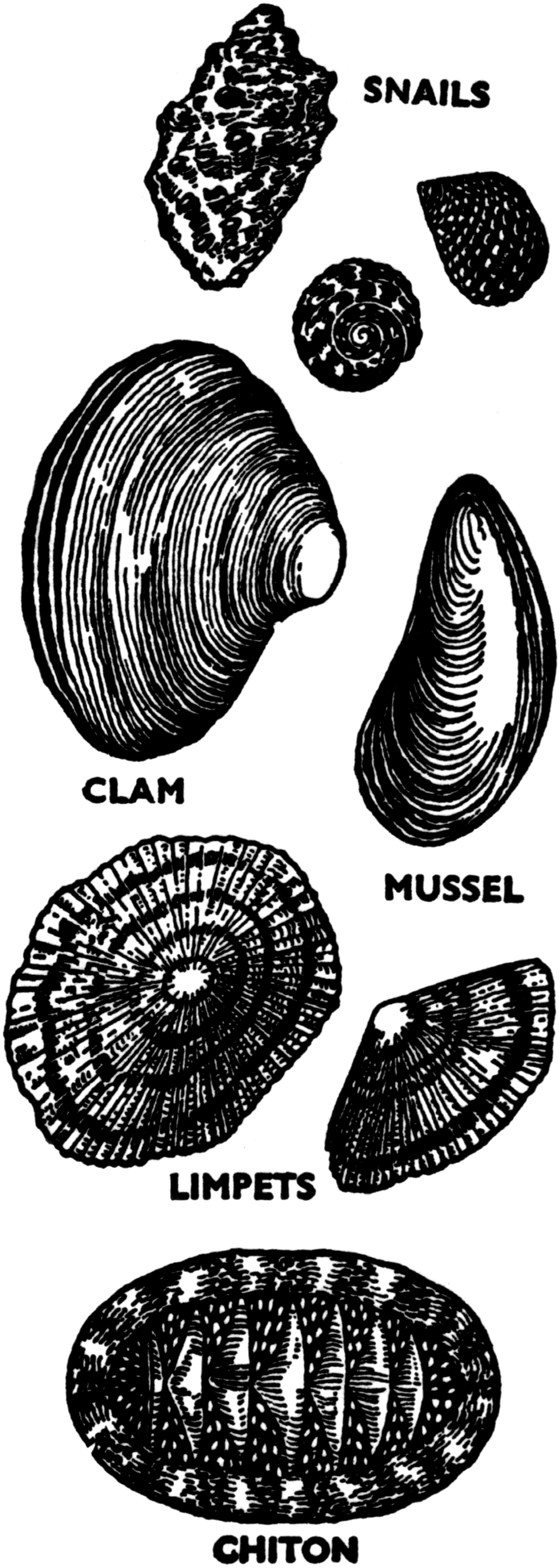


Fig. 32. Edible Seafood

Fish Food

78. The deeper streams, rivers lakes, and tidal pools are all worth fishing. Along most Arctic shores clams, mussels, snails, limpets, chitons, sea urchins and sea cucumbers, are plentiful. Don't eat shellfish that you find dead. Live shellfish move when touched or cling tightly to the rocks. The small blackish-purple mussel in Northern Pacific waters is poisonous at certain times of the year and should not be eaten. The chief characteristics of poisonous fish is that they lack ordinary scales, and instead have either a naked skin or are encased in a bony box-like covering or are covered with bristles, spiney scales, strong sharp thorns, or spines. Others puff up like a balloon on being taken out of the water. Cooking does not destroy the poisonous alkaloids in these fish. Never eat a fish that has slimy gills, sunken eyes, flabby flesh or skin, or an unpleasant odour. If on pressing the thumb against the fish it remains deeply dented, the fish is probably stale and should not be eaten. Avoid all types of jelly fish.

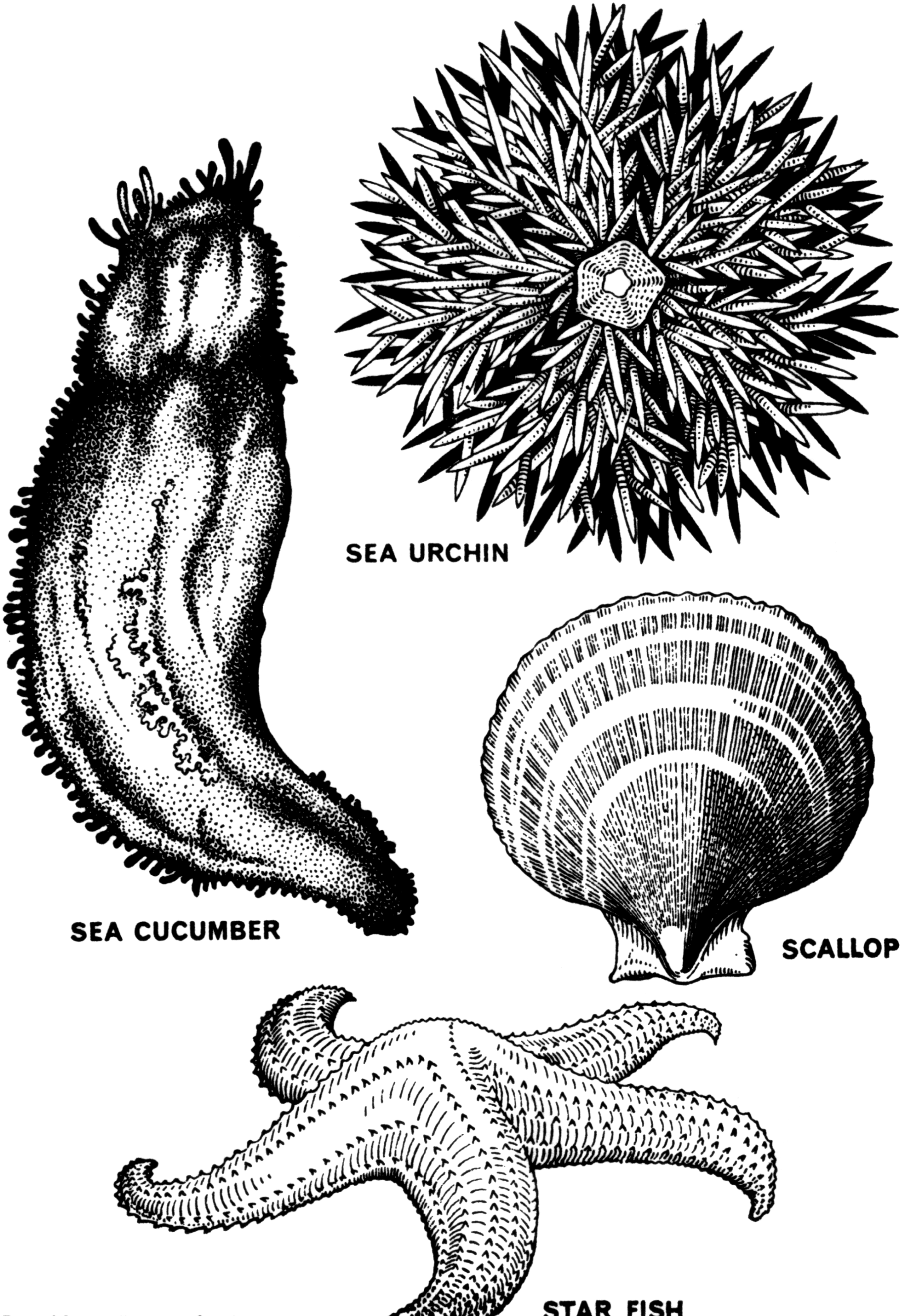


Fig. 32a. Edible Seafood

Fig. 33. Improvised Fish-hooks

79. **Fishing Equipment** The fishing gear in your survival kit is not your only means of catching fish. They can be speared, caught in improvised nets, or stunned with sticks and stones. In shallow water you can even catch them with your hands. Those who have a fish net, or know how to make one and use it properly, will catch the most fish. Remember that a net works twenty-four hours a day.

80. **Line Fishing** In addition to your fishing kit, hooks can be made from stiff wire or tin openers, and lines from the inner cords of your parachute shroud lines. Another effective device is a fishing needle of wood or bone sunk in bait (see Fig. 31). The needle is swallowed whole and a pull on the line swings it crosswirse, causing it to catch in the fish's stomach or gullet. Use the least appetising parts of animals and birds for bait. A white stone used for a sinker, or a bit of shiny metal or brightly coloured piece of material tied just above the hook will also attract fish.

(*a*) **Jigging** Fish may be caught by jigging for them. Let the hook, or a cluster of hooks attached below a "spoon" or shiny metal, down into deep water. Jerk it upward at arm's length, and let it sink back.

If you are fishing in deep water, be sure the hooks are weighted enough to carry the lure downwards quickly so that it suggests something alive.

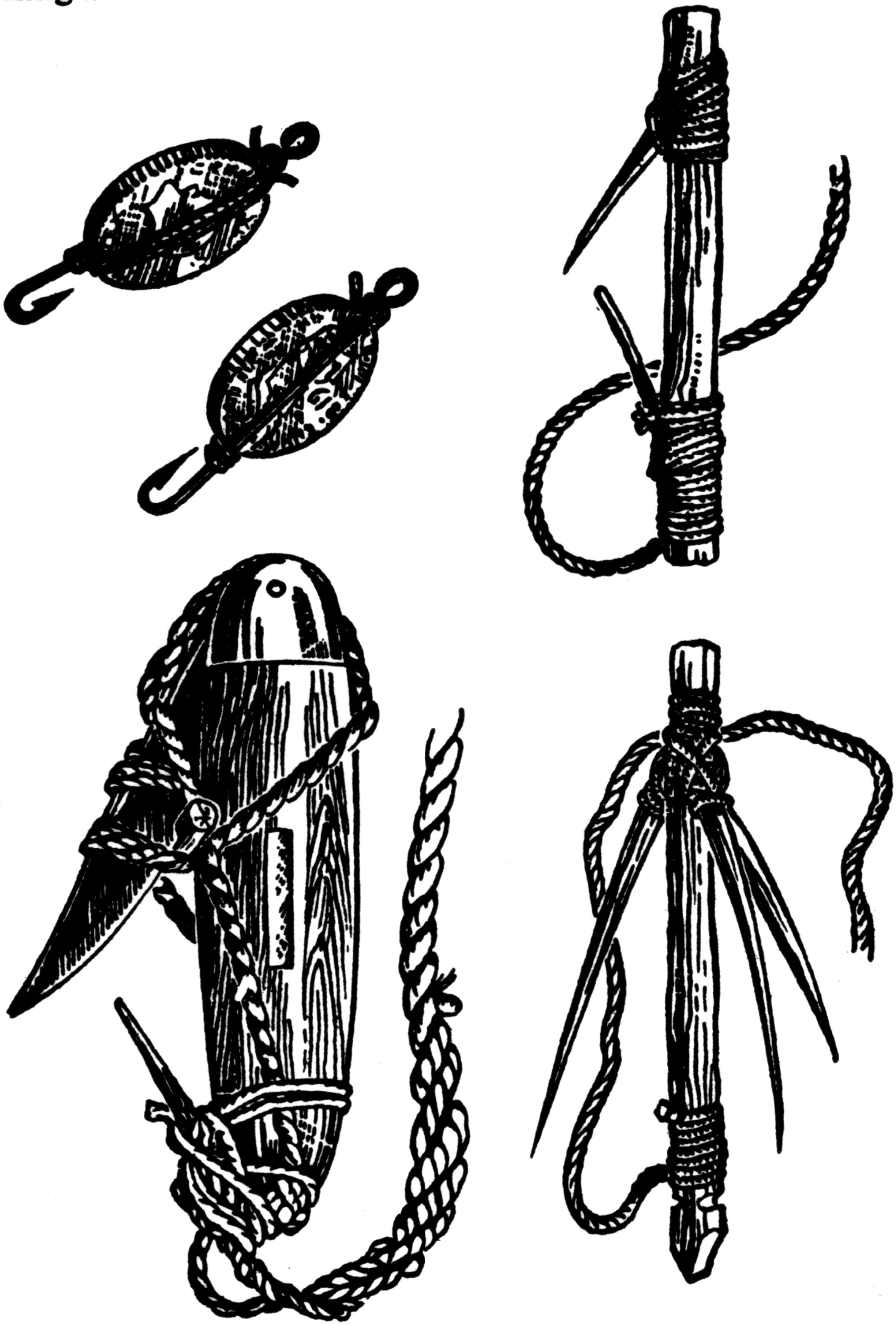
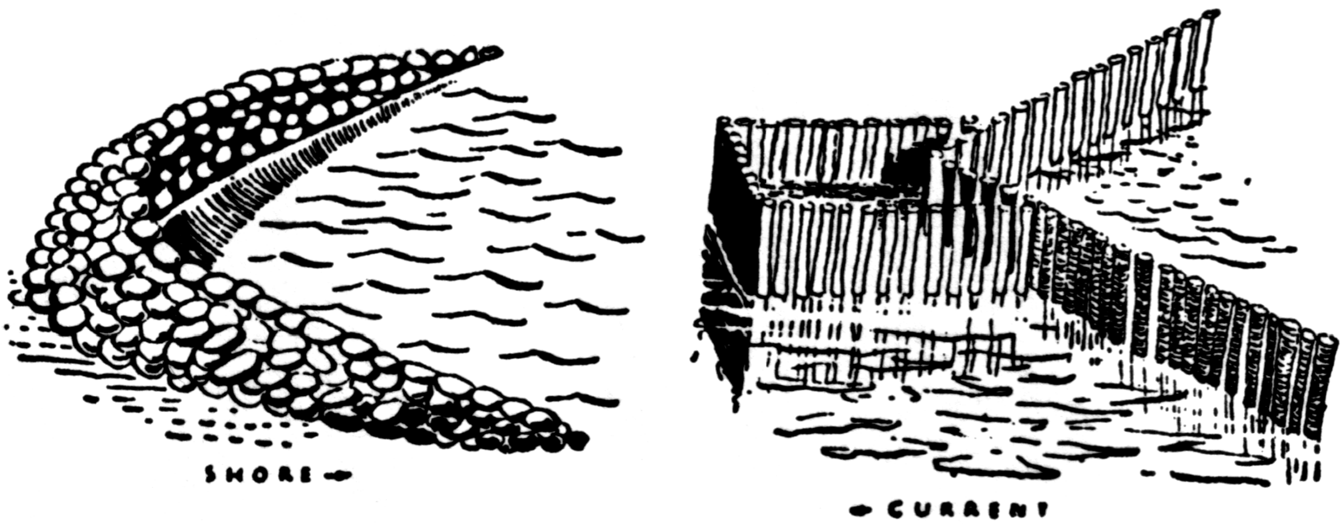


Fig. 33a. Improvised Fish-hooks

81. **Narrowing a Stream** To catch fish, a shallow stream may be narrowed by building an obstruction of stones or stakes out from both banks, leaving only a narrow channel through which the fish can swim. An improvized net is streched across this channel; be sure to secure it firmly with stakes or boulders or you will loose both net and fish. If you have no net, you can stand ready to hit, spear, or trap, the fish as they swim past. Keep very still while you wait—fish dart away at the first sign of danger.

82. **Diverting a Stream** If you are certain that a small stream has fish in it, divert it and so strand fish in the pools in the stream below the diversion.

83. **Tidal Fish Trap** To strand fish when the tide goes out, pile up a crescent of boulders on the tidal flat. Scooping out the area inside the crescent is not essential, but increases the effectiveness of the trap.



TIDAL FLAT FISH TRAP MAZE TYPE FISH TRAP

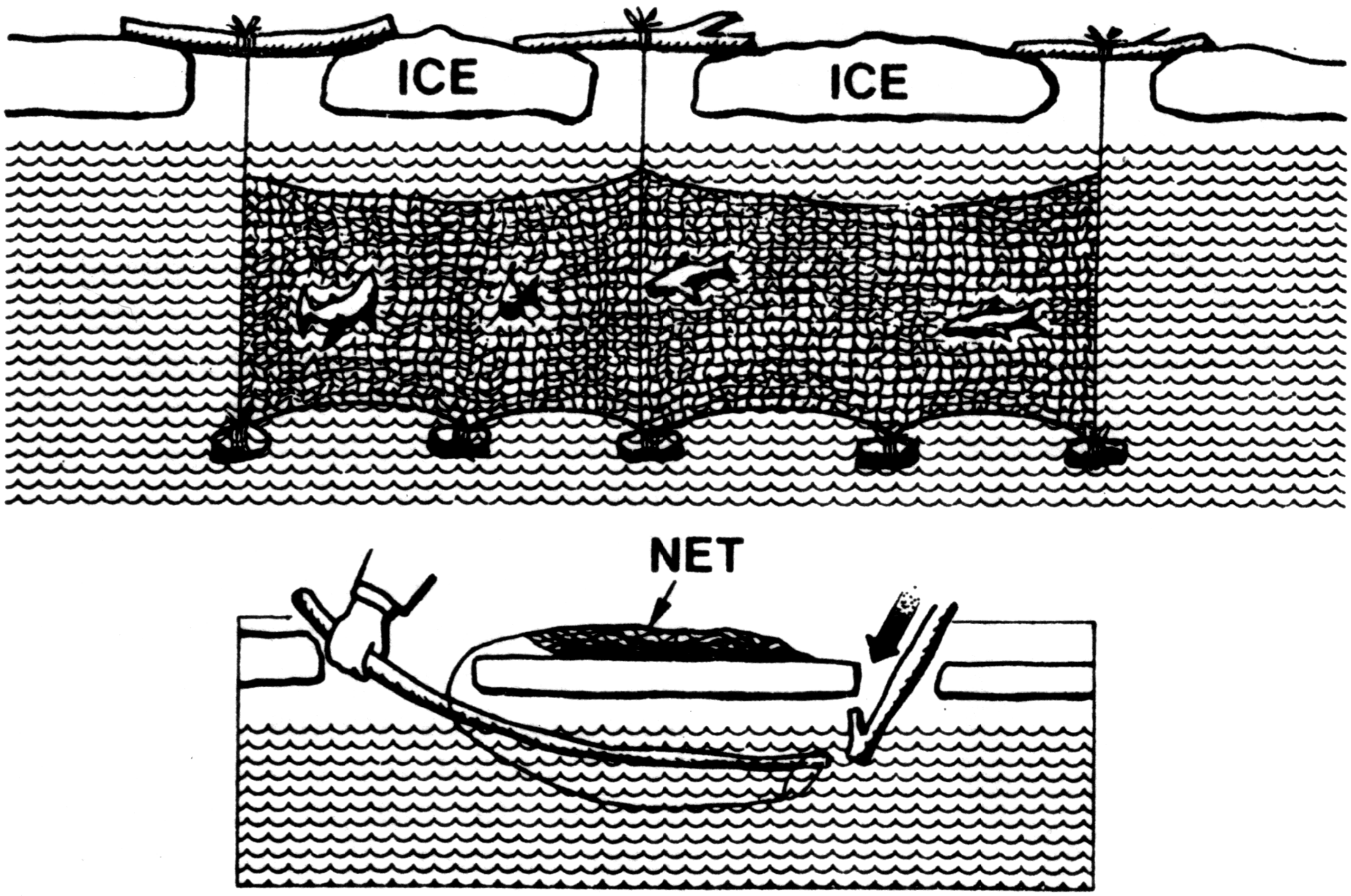
Fig. 34. Tidal Fish Traps

84. **White Fish Traps** If you come across a lagoon, select a spot about eight feet from it and two feet below water level. Dig a hole four feet in diameter, and join the hole to the lagoon with a trench about two feet wide, and deep enough to allow four inches of water to flow easily through the channel from the lagoon. Place a small log about three inches in diameter where the channel drops into the hole and fill the trench in behind it to smooth the

channel bed. Sit where the fish cannot see you and wait. Soon the fish will feel the current and, thinking that it will be taking them out to sea, allow it to carry them over the artificial falls into your pools.

85. **Fish in Tidal Pools** Tidal pools with masses of seaweed in them may seem to contain no fish, but you may find small fish among the seaweed near the surface and a few big ones deeper down. For the small fish you will need a scoop or net. For the big ones use a spear of fish catcher.

86. **Fishing through Ice** The main deterrent when attempting to fish through ice is thickness of the ice; it may be as much as 12 feet thick. Fishing with a hook and line through a hole in the ice requires no special technique, but setting a net beneath ice requires skill and patience. To set a net under ice, the float line may be fed under the ice by using a series of holes in the ice, one or two long poles, and a leader line tied to the float line. Fish get caught by entangling themselves in the mesh, therefore the net should be



Method of placing net under ice
Fig. 35. Setting Net under ice

fairly loosely tied to the float line to allow some flexibility in the meshes. The net may be supported in the water by a combination of poles, floats, and ropes. Weights made of almost anything, should be tied on to the bottom line.

Plant Food

87. Though plant food is not abundant in the Arctic, it is by no means absent. There are many varieties of berries, greens, roots, fungi, lichens, and seaweeds, which can be used as emergency food. In forested areas, food plants are most abundant in clearings, and long streams and seashores. On the tundra they are largest and most plentiful in wet places. Don't be discouraged by the bare appearance of northern vegetation: food is often hidden. Watch the feeding habits of animals, particularly birds; they will lead you to plants you might otherwise overlook. If you are on the march, gather food plants as you go along so that you will have enough for a meal by the time you make camp.

88. **Poisonous Plants** Generally speaking do not eat plants which taste bitter or have a milky sap. The following poisonous plants grow in the sub-Arctic forest; they do not normally grow north of the tree line:—

Fig. 36. Deathcup Aman —Poisonous

(*a*) *Mushrooms*. The common characteristics of the two species of poisonous mushrooms are that they have white gills and swollen or bulbous bases. The nutritive value of mushrooms is very small, and unless you are an expert they are best left well alone. There is a possibility that the very young of the deadly amanita mushrooms family may be mistaken for a puff ball. By cutting the ball in half you can make certain. If gills are found inside throw it away: no true puff balls have gills.

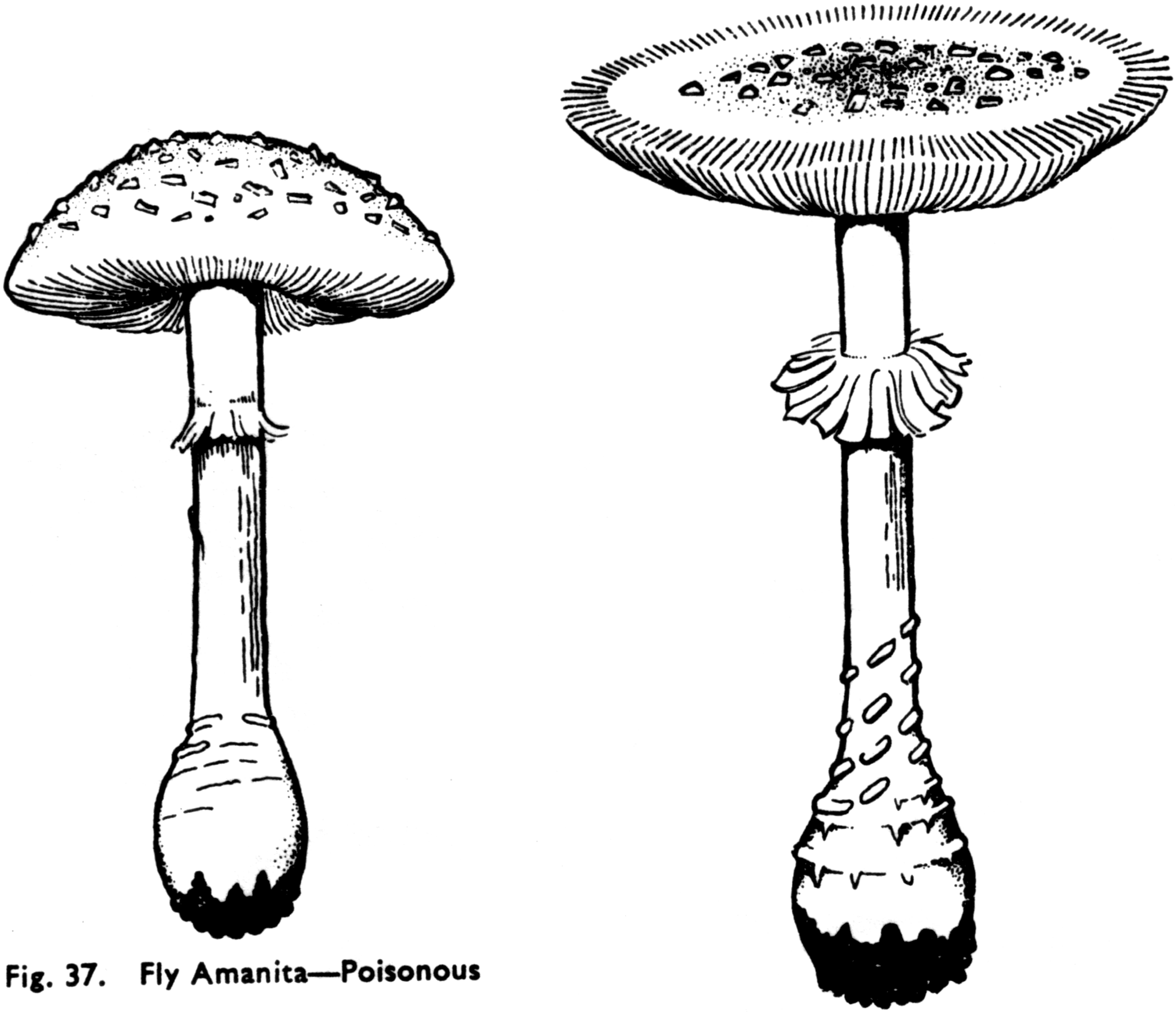


Fig. 37. Fly Amanita—Poisonous

(*b*) *Water Hemlock*. The water hemlock grows in the wet soil of river valleys in forested areas. On an average the plant is four feet tall, but in favourable locations it grows to six to eight feet tall. The arrangement of the flowers is a conspicuous characteristic which enables you to recognize immediately the members of this family (the parsley or carrot family). The root is hollow and has cross partitions. The leaves are streaked with purple and when crushed emit a disagreeable odour. (Fig. 38.)

(*c*) *Baneberry* The berries are usually red or white but may turn blue as they get older. It can be distinguished from the edible blueberry by the fact that baneberry bushes carry their fruits in clusters and have big leaves made up of several parts; edible blueberries grow singly (Fig. 39.)

Fig. 38. Water Hemlock—Poisonous

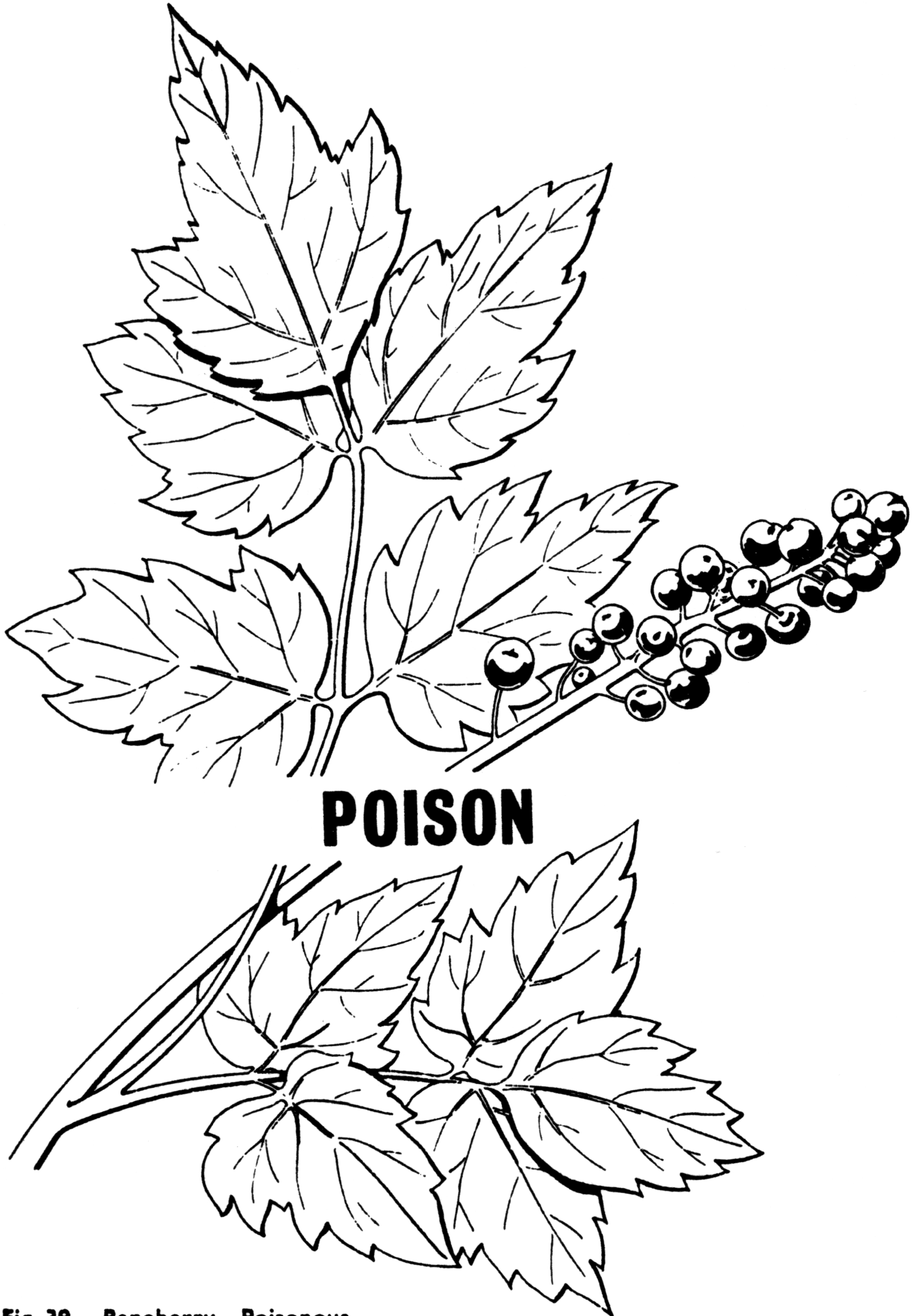


Fig. 39. Baneberry—Poisonous

Cooking

89. Whenever possible, cook your food before eating it. Meals should be prepared in sheltered places. Windbreaks and large stones should be used to protect the flame and reflect the heat. Hot embers provide the most heat.

90. Since fuel is usually scarce, it is advisable to cook by means of boiling, and if possible drink the cooking water. Boiling in water is the easiest and most satisfactory method of preparing fish and game under survival conditions. Boiling preserves the essential elements of the food. It is best to boil sea food in sea water; no additional salting is then required. Undercook rather than overcook; it saves vitamins and heat. Boil for two or three minutes only. Plant foods should be mixed with other foods in stews and soups. Lichens are most edible when soaked overnight, dried until brittle, crushed to a powder, and then boiled until they form a jelly. The jelly will make an excellent base for any soup or stew.

91. When a cooking pot is not available, in winter the food may be roasted or fried over a slow, non-smoking fire; in summer the food is best cooked by wrapping it in clay or mud and wet leaves, and baked in hot embers, When food is baked it should not be skinned or cleaned until it is cooked.

92. If no fire is available food becomes more palatable if dried or frozen. Before eating frozen food is should be brought to a temperature a few degrees below freezing since, when very cold the frozen food sticks to the lips and tongue. When carved or sliced into thin shavings, it is really palatable and does not appear raw.

Food Storage

93. Your food supply—especially fresh meat—will attract thieving animals. Another problem is the alternate freezing and thawing which is bad for any food. It is not necessary to thaw before cooking. Frozen food may take a little longer to cook, but otherwise it is unaffected. In summer, your fish can be cut into strips and dried in the sun; meat and game should be kept in a cool place in the shade. Newly-killed meat or game should be tied in a parachute cloth to keep out flies which otherwise will lay eggs

on the meat. A hole dug in the shady side of an embankment, with a wet piece of heavy material hung over the entrance, will give a small degree of refrigeration. A hole dug in the ground similarly covered will also make a good refrigerator. On the tundra a common method of storing food is to place it beneath a pile of boulders. If boulders are not available bury your food in the snow, and mark the spot. In timbered country, if it becomes necessary for every one to be away from the camp (one man should be left to operate the emergency signals) don't leave the food where animals can reach it. Tie it in a bundle and hang it from a tree at least six feet from the ground and a foot or two from the branches.

WATER

94. Your water supply will be limited only by the amount of heat available for melting snow and ice. In an effort to save fuel men deprive themselves of drinking water. Inefficiency, exhaustion and dehydration may occur through lack of water, even in the Arctic. Drink if possible two pints of water daily. The water lost through the sweat glands, and in the form of urine, must be replaced. The amount of water lost in the form of sweat, and therefore your requirements, can be limited by regulating your rate of work and removing some of your clothing whenever you begin to feel warm.

95. In summer, water can be obtained from streams, lakes, or ponds. On the tundra, pond water may be brown because of stain from grass roots and other plants, but it is fit to drink.

96. In winter, your water supply is most easily obtained from lakes under the ice and snow. The lower surface of the ice follows the contours of the top surface of the snow; dig where the snow is deepest and then chip through the ice under this to find the least cold water. Melt ice rather than snow for water; you will get more water for volume and it takes less time and heat. The deeper layers of snow are more granular and give a better yield of water than the soft upper snow. When melting snow, place a small amount in the pot at first, adding more as it melts. If you fill the pot with snow, the first water will be soaked up by the absorbent snow above it, leaving a cavity directly over the heated bottom of the pot and the pot will burn.

97. At sea you can obtain good drinking water from old sea ice. Ice a year old rarely has any noticeable saltness, while ice two or three years old is generally fresher than the average river or spring water. Old sea ice can be distinguished from the current year's ice by its rounded corners and bluish colour, in contrast to the rougher sea ice which has a milky grey colour. In summer, drinking water can be obtained from pools in the old sea ice. Avoid pools near the edge of the floe where salt water may have blown in.

98. **Purification of Water** If there is any doubt as to the quality of the water you intend to drink or cook with, it should be purified by one of the following methods:—

(*a*) *Halazone Tablets*. Crunch and dissolve one halazone tablet in each pint of water. Shake well and allow to stand for half-an-hour. If this is insufficient to produce a distinct smell of chlorine, add more halazone until the odouris present.

(*b*) *Boiling*. Boil the water for at least three minutes and allow any sediment to settle before using.

HEALTH HAZARDS

Hypothermia

99. Hypothermia is the condition existing when the body temperature is below normal. Low temperature, winds, and dampness, supplement each other in depleting the body's heat resources to produce a sub-normal temperature. Hypothermia may be recognised be decreasing resistance to cold, excessive shivering, and low vitality.

100. The treatment consists of returning the body temperature to normal. The patient should be put in his sleeping bag, or a bed improvised from a parachute canopy, the buttocks, shoulders, and feet, being well insulated. The patient should be warmed by placing heated rocks, wrapped in some material, near the various parts of the body. If the number of heating units is limited place them

as far as they will go in this order: pit of the stomach, small of the back, armpits, back of the neck, wrists, and between the thighs. Stimulation with hot drinks will also help if the patient is conscious. Avoid the use of alcohol; it opens the blood vessels at the surface of the skin allowing heat to be lost more rapidly. A victim of hypothermia is not cured when his body temperature returns to normal. Build up his reserves of body heat. To prevent hypothermia take all possible measures to conserve body heat.

Frostbite

101. **Areas Most Affected** Frostbite affects particualrly the exposed parts of the body and regions which are farthest from the heart and have the least circulation, *i.e.* the face, nose, ears, hands, and feet.

102. **Prevention** To avoid frostbite remember these precautions:—

(*a*) Keep wrinkling your face to make sure that stiff patches have not formed. Watch your hands.

(*b*) Watch each other's faces and ears for signs of frostbite.

(*c*) Don't handle cold metal with bare hands.

(*d*) Avoid tight clothing which will reduce circulation and increase the risk of frostbite.

(*e*) Avoid exposure in high winds.

(*f*) Avoid spilling petrol on bare flesh. Petrol-splashed flesh in sub-zero temperatures will freeze almost at once.

(*g*) Do not go out of your shelter, even for short periods, without adequate clothing.

(*h*) Take special care if you are unfit or fatigued; the risk then increases.

(*j*) Don't let your clothing become wet from sweat or water. If it does, dry it promptly.

103. Symptoms

(*a*) Frostbite first appears as a small patch of white or cream-coloured frozen skin, which is firm to the touch, and feels stiff. Frostbite can be felt by making faces and moving all the skin on the face and forehead. The subject may feel a slight

Fig. 40. Making Faces to Prevent Frostbite

pricking sensation as the skin freezes, or may not notice it at all. If treatment is given at this tage the consequences will not be serious; but if the process goes further, the deeper tissues of muscle and bone are frozen, the blood vessels become clotted, and so much tissue may be destroyed that part of limb, an ear, or a nose, may be lost.

(*b*) If the frostbite is quite mild when the area is warmed up, there will be some swelling and redness of the skin with a little pain and, as the condition heals, the skin may scale off.

(*c*) If the bite is deeper and more serious, swelling and pain are marked and blisters form. These may become infected, forming ulcers, and in the worst case the tissues become grey, then black and dead. Such tissues will fall off eventually.

104. **Treatment** Careful and immediate attention must be given.

(*a*) Very slight cases may be treated by simply getting out of the wind. A small area may be warmed by placing a bare hand over it, covering the outside of the hand with its mitt. The woollen pads on the backs of the mitts may provide enough warmth in some cases.

(*b*) Frostbitten hands should be thrust inside your clothing against your body.

(*c*) Frostbitten feet should be thrust inside a companion's clothing if you are out in the open.

(*d*) Keep the part covered with dry clothing until you reach shelter.

(*e*) Never rub frostbite with snow.

(*f*) In more serious cases the patient will almost certainly require treatment for exposure. Get him to shelter or build a shelter round him.

(*g*) If blisters appear, do not burst them. Dust them with an antiseptic powder.

(*h*) Cover the frostbitten parts lightly with surgical dressings, or clean soft clothes. Wrap up the parts loosely.

(*i*) Never rub a frostbitten area.

(*k*) Never warm up frostbite quickly by holding before the fire or dipping into hot water, or by any other means. Use "animal" warmth only.

(*l*) If there is severe pain give morphia if available. Very severe pain is usually an indication that frostbitten parts have been made too hot and further damage is occuring.

(*m*) Keep the damaged areas at rest.

Snow Blindness

105. Snow blindness is a temporary form of blindness caused by the high intensity and concentration of the sun's rays, both direct and reflected from the snow-covered ground or ice and ice crystals in the clouds. However, snow blindness may occur during a bright overcast when there is no direct light, but a bright general haze from all directions. It occurs most frequently when the sun is high, particularly in areas which do not lose their snow cover.

106. **Symptoms** First the eyes become sensitive to the glare, then blinking and squinting occurs. Next the landscape takes on a pinkish tinge and the eyes begin to water. Blinking and watering become more intense and the vision becomes redder, until a sensation similar to that of sand in the eyes is noticed. If the exposure is continued the sensation becomes more violent until the vision is blanked out completely by a flaming red curtain. It is impossible to open the eyes or black the red vision. There is intense pain which may last three of four days.

107. **Treatment** The treatment consists of getting the person into a dark place. If there is no dark place available a blindfold may be used. The pain is aggravated by heat and may be relieved by the application of a cool wet compress. Time is the only cure.

108. **Prevention** The wearing of the standard goggles in the personal survival kit is recommended. If for some reason you have no goggles, some kind of goggles can be made from wood, bark, cloth or paper; do not use metal. Blackening the skin round the eyes will cut down the number of rays entering the eyes.

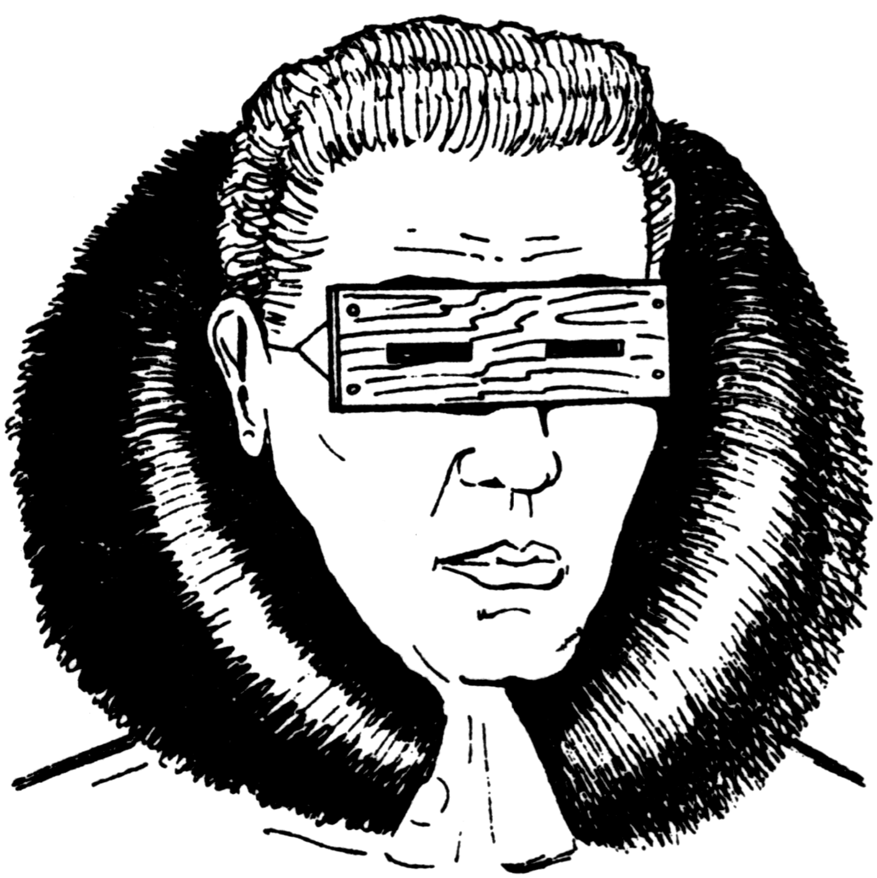


Fig. 41. Protection against Snow blindness

Carbon Monoxide Poisoning

109. All forms of fires and stoves are liable to give off carbon monoxide gas, and are therefore a potential danger in shelters unless ventilation is adequate (*see* para. 70). Poisoning by these fumes is common in severe cold conditions because of the very natural tendency to batten down closely. The gas is colourless and odourless.

110. The effects of breathing the gas are insidious. There may be slight headache, dizziness, drowsiness, nausea, and perhaps vomiting, but usually these symptoms are very mild and may pass unnoticed, and the subject becomes unconscious without any warning. Unless discovered promptly the subject will die as the effects of the gas increase.

111. The treatment is simple. Remove the patient to a well-ventilated place and encourage him to breath evenly and regularly. If he is unconscious and breathing shallowly, apply artificial respiration. Administer oxygen if available. When he is conscious keep him warm and at rest and give hot drinks. Do not allow him to exert himself until he is fully recovered.

Personal Hygiene

112. Strict attention must be paid to personal cleanliness to prevent skin and intestinal infections which are associated with neglect of personal hygiene.

(*a*) Hair and beards should be trimmed as short as possible. Frost accumulates readily on beards and can only be removed by thawing.

(*b*) Winter survival is not conducive to bathing; however, it is still necessary to remove accumulated body oils and perspiration from the skin. Under severe conditions a dry rub-down is all that is possible; otherwise wash the body with a damp rag.

(*c*) The teeth and mouth should be cleaned daily. Feathers make a good toothpick and several tied together make a reasonable toothbrush. A piece of cloth can also be used.

(*d*) Attend promptly to any tender skin, particularly on the feet. It may prevent real trouble later on.

Camp Hygiene

113. Use a little commonsense when arranging your camp site. Site your lavatory to the leeward of the camp, well away from your shelter and water supply. Clean the camp site regularly, and above all do not contaminate your water supply.

General Health

114. Conserve your energy. Do not rush around aimlessly. Avoid fatigue. Get plenty of sleep. If you cannot sleep, just lie down and relax your body and mind. You will not freeze to death when you sleep unless you are utterly exhausted. If you are doing hard work remove excess clothing before you get hot, and rest as soon as you begin to feel hot, at least for five minutes in every thirty.

CLOTHING PRECAUTIONS

115. It has been previously been stated that your clothing is your first line of defence in Arctic survival, and it follows that care of the clothing is most important. The following points should be particularly observed.

116. **Regulation and Ventilation** Strange as it may seem, one of the chief causes of freezing to death arises from having become overheated in the first place. Excess body vapour will condense and in extreme cases will freeze. This has two effects: the moisture will destroy the insulating qualities of the underclothing, and the water vapour, being a good conductor of heat, will draw heat from the body. Constantly regulate your clothing so that you do not become hot enough to sweat. This is a considerable nuisance, but absolutely necessary. Slacken off all draw cords, open up the clothing at the neck, and loosen belts to allow ventilation. When necessary, remove enough layers of clothing to keep cool, whether you are indoors or travelling, or working outdoors. Replace the clothing as soon as you start to cool off.

117. **Repairs** Immediately mend tears and holes, particularly in outer garments which must be windproof.

118. **Drying Out** Dry your garments as soon as possible if they have become wet. Clothing should be hung high up in shelters to dry, as the warmest air is high up. In emergency, clothing can be dried by body heat, by putting it under your outer clothing or inside your sleeping bag. Mukluks and boucherons should be dried in the open by sublimation, that is, allowing the perspiration to condense and then freeze. The frozen perspiration can then be brushed out.

119. **Fluffing Out** Compression reduces the fluffiness of a material and hence the volume of insulating air it can obtain. Socks must be turned frequently and fluffed out to prevent matting. Insoles should be changed from foot to foot to prevent them always being compressed in the same spot. All other woollen garments should be fluffed out regularly.

120. **Spares for Changing** If possible carry extra dry clothing for changing, particularly socks. Several layers of the parachute canopy wrapped round your feet are better than wet socks. Dry grass stuffed between the layers provides useful insulation.

121. **Frost Removal** Remove snow and hoar frost from clothing by beating, shaking and scraping, before entering a warmer atmosphere. Willow canes or a whisk made of spruce tips can be used for this purpose. Snow or frost does not wet clothing unless it is melted by warmth, so if you cannot remove the snow it is better to leave the outer garments where it is cold, so that the snow will not melt.

122. **Snow Contact** Don't sit down directly on the snow. Your body heat will melt it and your clothing will become wet. Always sit on surplus clothing, a log, or some piece of equipment. Don't put your hands with snow-covered gloves into your pockets. Shake off the snow first.

123. **Tightness of Clothing** Avoid tight clothing, particularly tight footgear and handwear. Don't try to cram too many pairs of socks into your footwear, because a tight fit is as bad as, if not worse than, insufficient covering.

124. **Cleanliness** Keep all your clothing as clean as possible. Dirty, matted clothing is less warm. The dirt will fill the space normally occupied by the insulating air.

125. **Gloves** Don't lose your gloves or mittens. Secure them, by the loops provided, with a neck string.

126. **Tacking Chances** Don't take chances about clothing. Unprotected fingers and ears can be frostbitten in a few minutes.

127. **Sleeping Bags** Never get into your sleeping bag wearing wet clothing. Sleep in the minimum clothing required for warmth; naked if possible. Turn the bag inside out in the morning and dry it before a fire or by sublimation. When it is dry, reassemble it and roll it up tightly until it is needed again. Don't sleep with your head in the bag, otherwise moist exhaled air will enter the bag. Sleep with your head in the aperture, and cover your face with your necksquare folded up to at least four thicknesses.

128. **Clothing Hints**

(*a*) When walking in deep snow, wear your trousers outside your footwear and secure the bottoms of the legs with the draw cords.

(*b*) If you are unfortunate enough to fall into water, immediately roll yourself in the snow. The snow will act as a blotter and soak up the water. The violent exercise will generate body heat and will also knock off any unsaturated snow. If possible wring out underclothing, but let the outer clothing freeze to maintain and protect body heat.

(*c*) Never take off boots filled with water until you are in some form of shelter. As long as water remains liquid there is no danger of frostbite. Walking generates enough heat to prevent solidification for a considerable time even at very low temperatures.

(*d*) Footwear can be made temporarily waterproof by dipping them, while on the feet, into water, until a film of ice is formed on the outside. The footwear will not let in water until the ice has melted. Coating with ice is an extreme emergency procedure and should never be used if there are other alternatives.

129. From mid-June to mid-September, when the first heavy frosts come, your worst enemies are the insects. During this period, there are ten times as many mosquitos per square mile over two-thirds of the land north of the tree line than in the tropics. Hence the provision of the head net and insect repellant cream in your personal survival kit.

130. There are four insect families: mosquitos, black flies, deer flies, and midges. They do not resemble each other in general appearance, but they are alike in several significant ways:

(*a*) They all bite, that is, they do not sting.

(*b*) They do not generally carry disease.

(*c*) They are primarily daytime insects.

(*d*) If it turns cold, they become inactive, even when they are abundant.

(*e*) Only the females bite.

(*f*) During their larval stage they live in water.

Types

131. (*a*) *Mosquitos*. Mosquitos need no description; they are universal pests.

(*b*) *Black Flies*. Sometimes known as sandflies or buffalo gnats. Their bites stay open and will continue to bleed for some time; the bite causes severe swelling. They attack especially at the collar line, and, if they get inside the clothing, at the waist line.

(*c*) *Deer Flies*. These large pests are also known as gadflies. Other flies in the same family are mooseflies; these are larger still and are also called horseflies or bulldogs. The last name is particularly apt in view of their tenacity and the size of the hole they drill in the skin. Their bite is like the cut of a scalpel, drawing blood in a trickle.

(*d*) *Midges*. These are minute flies about one twenty-fifth of an inch long; also known as no-see-ums, pinkies, and gnats. They are persistent blood suckers and cause a sharp burning pain out of all proportion to their size.

Protection

132. **Clothing** Wear two thicknesses of light clothing: mosquitos bite through one layer but rarely through two. Tuck your trouser legs in your boots and your sleeves in your gloves. Whenever you can, cover bare flesh with clothing.

133. **Headnets** Make sure your headnet is well tucked in to the collar of the shirt.

134. **Insect Repellant** Apply to the face and exposed skin every four hours. Apply to the face even when wearing a headnet; midges are small enough to penetrate the mesh.

135. **Smudge Fires** Any green wood or green leaves will produce an insect repelling smoke.

136. **Parachute Canopies** In summer, the aircraft may be used as a shelter and can be made insect proof with parachute canopies.

TRAVEL

137. The experience of Arctic crashes reveals that the best policy for survivors is to stay with the crashed aircraft and await rescue. Travel to a camp site should be undertaken, however, if the scene of the crash is endangered by natural hazards, such as crevasses and avalanches. There may be times when walking home is considered to be the only solution.

Considerations

138. **Your Position** Have you been able to fix your position? Quite often the reason for crash landing is that the aircraft is lost. An approximate position, say within 50 miles, is worthwhile for the purpose of narrowing the search by air. But it is not accurate enough to use as a departure point in an attempt to walk out. You must know the exact location of your camp and your objective.

139. **Wireless Contact** Is the search organization aware of your plight and your position? Was your distress message acknowledged? Have you made wireless contact since the crash?

140. **Physical Condition** Even with snow shoes and skis, Arctic travel is slow, strenuous and hazardous. Don't overestimate your physical capabilities.

141. **Weather** The weather should be assessed from two angles. Is the prevailing weather likely to hinder search forces? Is the weather conducive to an Arctic route-march and sleep in temporary shelters?

142. **Orientation** You must have reliable methods of determining and maintaining your intended route. In the barren lands particularly, you must have a compass. Should you lose your compass the following methods may be used to determine direction:—

(*a*) *Sky Map*. A high uniform overcast reflects the surrounding terrain. Clouds over open water, timber, or snow-free ground will appear black, while clouds over sea ice or uniform snow covering will appear white. Pack ice or drifted snow are indicated by a mottled appearance on the surface of the cloud. New ice is indicated by greyish patches on the sky map. A careful study of the earth's reflection on the clouds may be used for determining the proper direction to travel.

(*b*) *Bird Habits*. Migrating waterfowl fly towards the land in the thaw. Most sea birds fly out to sea in the morning and return to land at night.

(*c*) *Vegetation*. Although there are few trees on the tundra, the moss theory still applies; moss is heaviest on the north side. The bark of the alders is lighter in colour on the south side than on the north side. Don't rely on one observation; make several and average the direction. Lichens on rocks are most numerous on the south side where they receive the greatest warmth of the sun.

(*d*) *Stars*. In the northern hemisphere, true north can be ascertained from the constellation of the Great Bear, which points to Polaris (North Star), the star over the North Pole. Trying to estimate your latitude by measuring the angle of Polaris above the horizon will give you only a very approximate

result, unless you have a sextant and tables. In the southern hemisphere, the Southern Cross indicates the direction of south. Other constellations, such as Orion, rise in the east and set in the west, moving to the south of you when you are north of the equator and vice versa.

(*e*) *Sun.* If you have the correct local time on your watch, the shadow cast by an object at 1200 hours will indicate north and south. The object must be perpendicular to the ground and straight. In the northern hemisphere the base of the shadow will indicate south and the tip will indicate north. If you have no watch, place a straight object in the ground or snow on a level spot. Starting in the morning, and, continuing about once every hour throughout the day, mark the point at the tip of the shadow. At the end of the day, connect these points and you will have a line which runs true east and west. The shortest distance between the base of the shadow and the east-west line will indicate north and south. The method of determining direction by pointing the hour hand of a watch at the sun is considered inaccurate and should not be used.

143. **Final Decision** A crashed aircraft with a prominent signals area is more likely to be spotted from the air than a man on the march with limited signalling devices. Your final decision should be based on two factors: your nearness to civilization and the probability of rescue. Once you have made your decision, stick to it. The decision will have been reached after considering all the factors when your minds were fresh. As time goes on, your powers of reasoning will deteriorate and there may be a tendency to consider the factors individually instead of collectively. However, if it is at all possible, or if you are in doubt, *stay with the aircraft*.

Routes

144. The majority of the settlements are to be found on the rivers or on the coast. Water is the highway of the north. Dog teams and sledge trains travel on the ice in the winter. In addition, food and fuel are available along the waterways both in summer and winter. Travel downstream to reach civilization, except in Siberia where the rivers flow north.

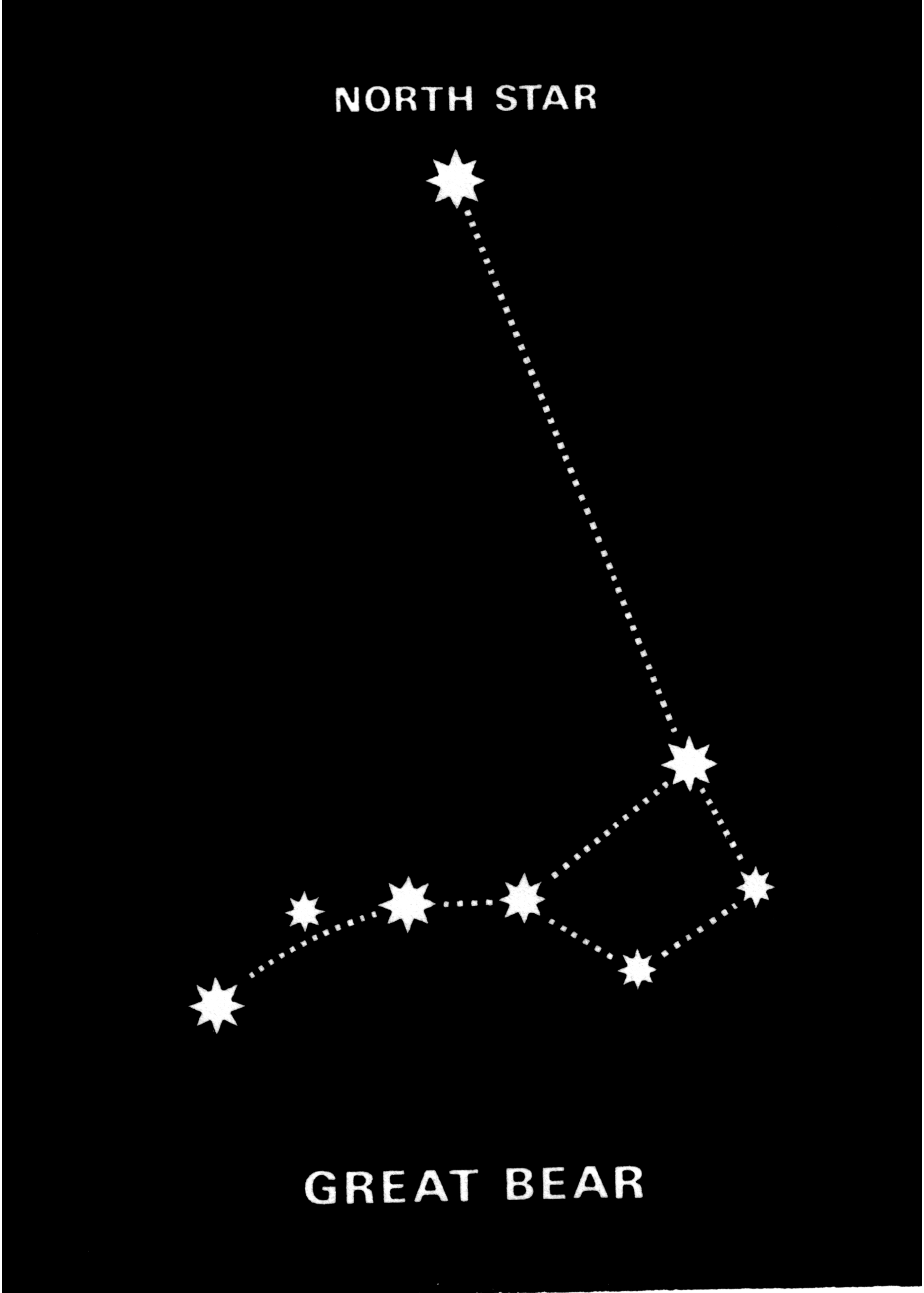


Fig. 42. Great Bear and North Star

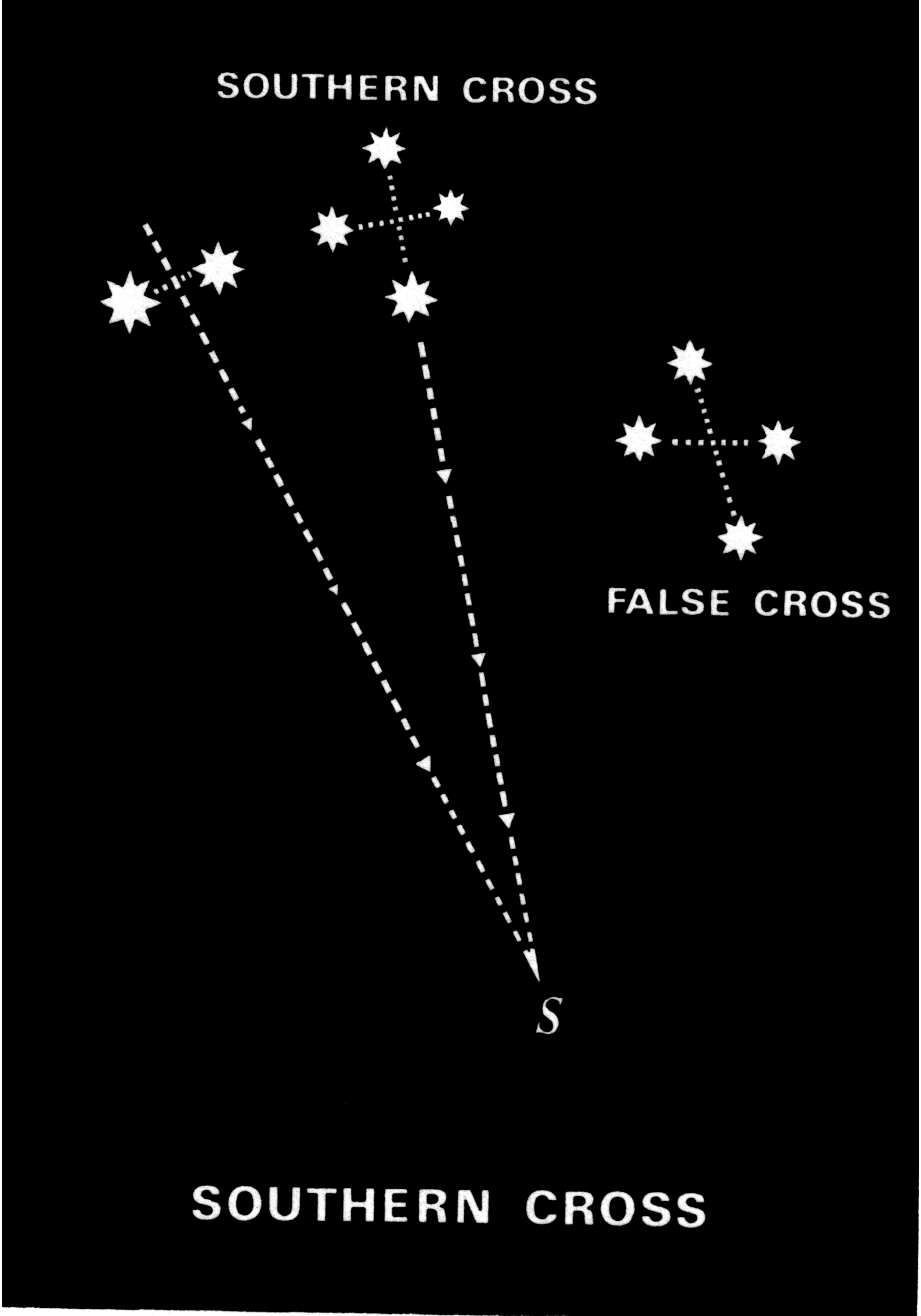


Fig. 43. Southern Cross

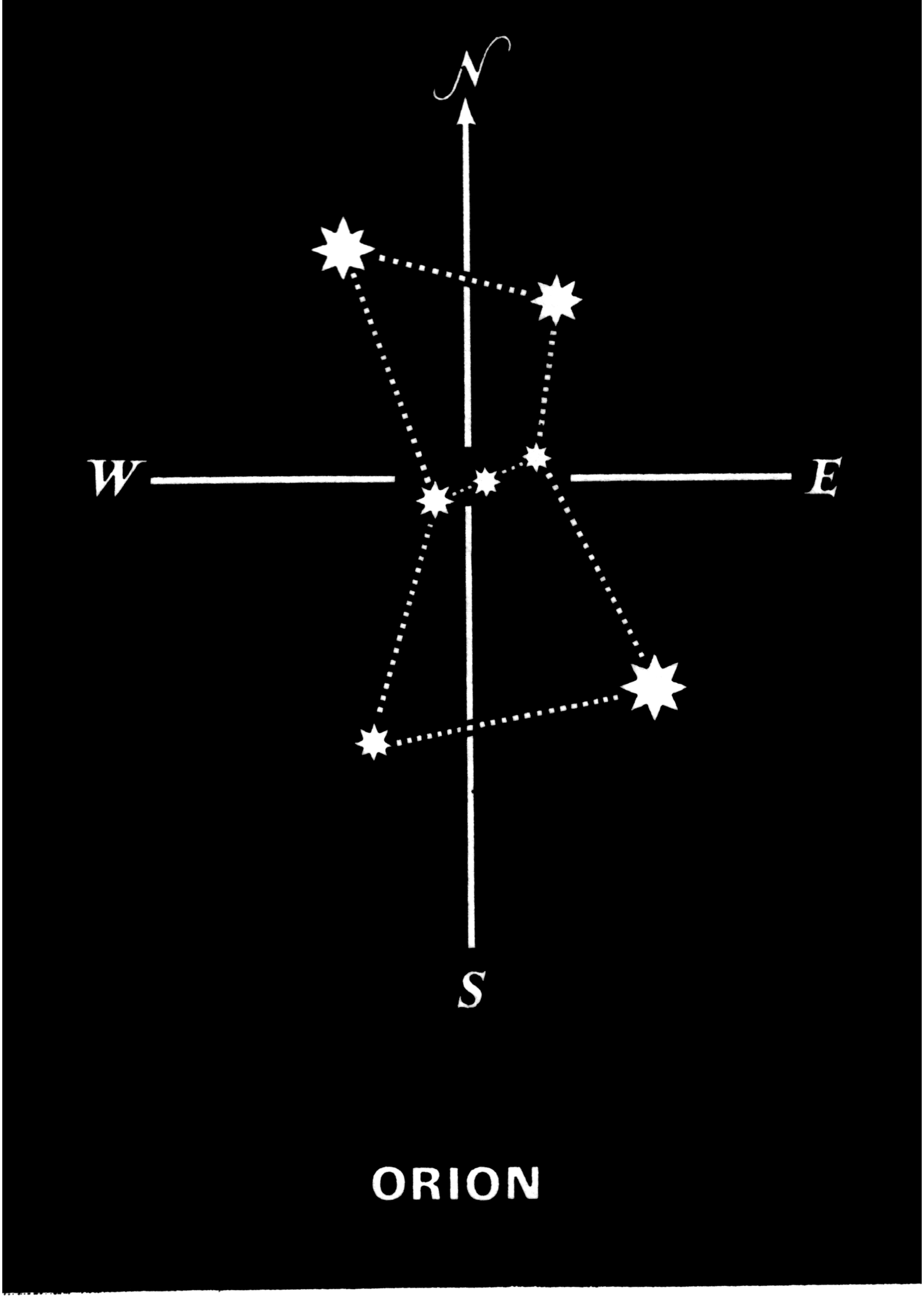


Fig. 44. Orion

145. Mountain Routes Mountain routes, where ice caps, glaciers, crevasses, and avalanches may be encountered, are extremely hazardous and should be used only if there is no alternative. The minimum requirements are a climbing rope, two ice axes, and an experienced leader. If any one of these is not available select another route. In areas where avalanches are prevalent, travel in the early morning when it is coldest. At all times proceed with extreme caution.

146. Timber Country Snow lies deep in the timber country and travel is extremely difficult without snowshoes or skis. Two miles a day in these circumstances is good progress. Trail breaking is very strenuous, and it should be taken in turns for periods of not more than five minutes. Rest for five minutes about every half-an-hour. When possible travel by the rivers. Make a raft or use your dinghy in the summer, and travel on foot over the ice in winter. When travelling on river ice keep on the inside of the bends; the swifter current on the outside of the bends wears the ice away from below. At river junctions walk on the far side, or take to the land until you are well downstream from the junction. When river travel is not feasible, travel along ridges. In winter the snow does not lie deep on the ridges; in summer the ridges are drier and firmer under foot.

147. Barren Land Routes Barren land travel without snowshoes or skis is difficult and slow. You cannot afford to follow the rivers, which wind and twist and greatly increase the distance to be covered. Beware of thin ice on the edges of tundra lakes and in the connecting channels. Lack of landmarks, blowing snow and fog, emphasize the need of a compass for barren land travel. If your tracks are clear, check your course by taking back bearings of your tracks; otherwise proceed in single file about 30 paces apart. The last man carries the compass and, using the middle men as sighting objects, controls the course of the first man by calling out instructions to him. Constant compass check will ensure that you are travelling in a straight line, which is the shortest distance. Summer travel in the barren lands presents another problem. Soggy vegetation and bogs make the going slippery and heavy. Tundra lakes, quicksands, and swamps must be avoided. In these circumstances it is usually preferable to float down a river than to travel across country.

148. **Sea Ice Routes** On sea ice travel in one party; there is nothing to be gained by anyone who remains behind. The problems of coursekeeping are identical with those on the barren lands, but the movement of ice floes makes it difficult to determine your actual track. Pressure ridges and hummocks may be used as landmarks over short distances only, since they are constantly moving. The unreliability of the magnetic compass in high latitudes necessitates course checks on the sun and stars. Avoid tall, pinnacled icebergs which are liable to capsize. For shelter at sea, look for low, flat-topped icebergs.

149. **Trail Equipment** The amount of equipment you can take on the trail will depend on what you can carry, or haul on improvised sledges. Individual packs, adapted from the personal survival packs, should be worn high up on the shoulders and should not exceed a weight of 35 pounds. Avoid carrying whenever possible; float down the rivers in summer and haul a sledge in winter. Sledges can be made from cowlings, doors, pieces of fuselage, or timber. A single tow line attached to a bridle, with individual shoulder loops tied in, is preferable for travel over snow. Only one trail need necessarily be broken. Over ice, it is better to have several towlines attached to the bridle, since they enable each man to choose his own footholds. It may be necessary to leave behind many useful atricles. Basically you will require food, shelter, and fuel, or means of obtaining them. The value of each piece of equipment must be carefully considered. For instance, a fuel stove is superflous in timber country, but is an absolute necessity on sea ice. Always carry spare clothes and a sleeping bag. Travel is difficult over any terrain without snowshoes or skis. Short wide skis are best; they should be about three feet long and eight inches wise. They can be made of metal or timber. Snowshoes, which are simply load-spreaders, can be made of metal tubing, spruce, or willow. Finer limbs can be woven in and secured with shroud lines.

150. **Preparation** While the advice to all survivors is "*Stay with the aircraft*", the possibility of the necessity for travel should be recognized at the beginning of the survival period. Items of equipment such as snowshoes, skis, and sledges, should be made and tested before setting out on the trail. Indeed, they will be very useful around the camp site for collecting fuel and foraging for food.

151. **Blaze your Trail** If the entire survival party is going to walk out, or if a small group is setting out to get help, messages stating the intended route should be left at the base camp. In the Arctic communication is very slow, and the more signs of your presence left along the trail the greater is your chance of being found. Mark your trail clearly. Strange trails are nearly always followed by trappers and Eskimos. On the trail make your camp well before nightfall; leave plenty of time to build your shelter, prepare emergency signals, and have a hot meal. The following morning, all signals, particularly snow writing, should be changed to large arrows showing the direction the party has taken.

152. Finally, it must again be strongly emphasized that if you are in any doubt at all **stay with the aircraft.**

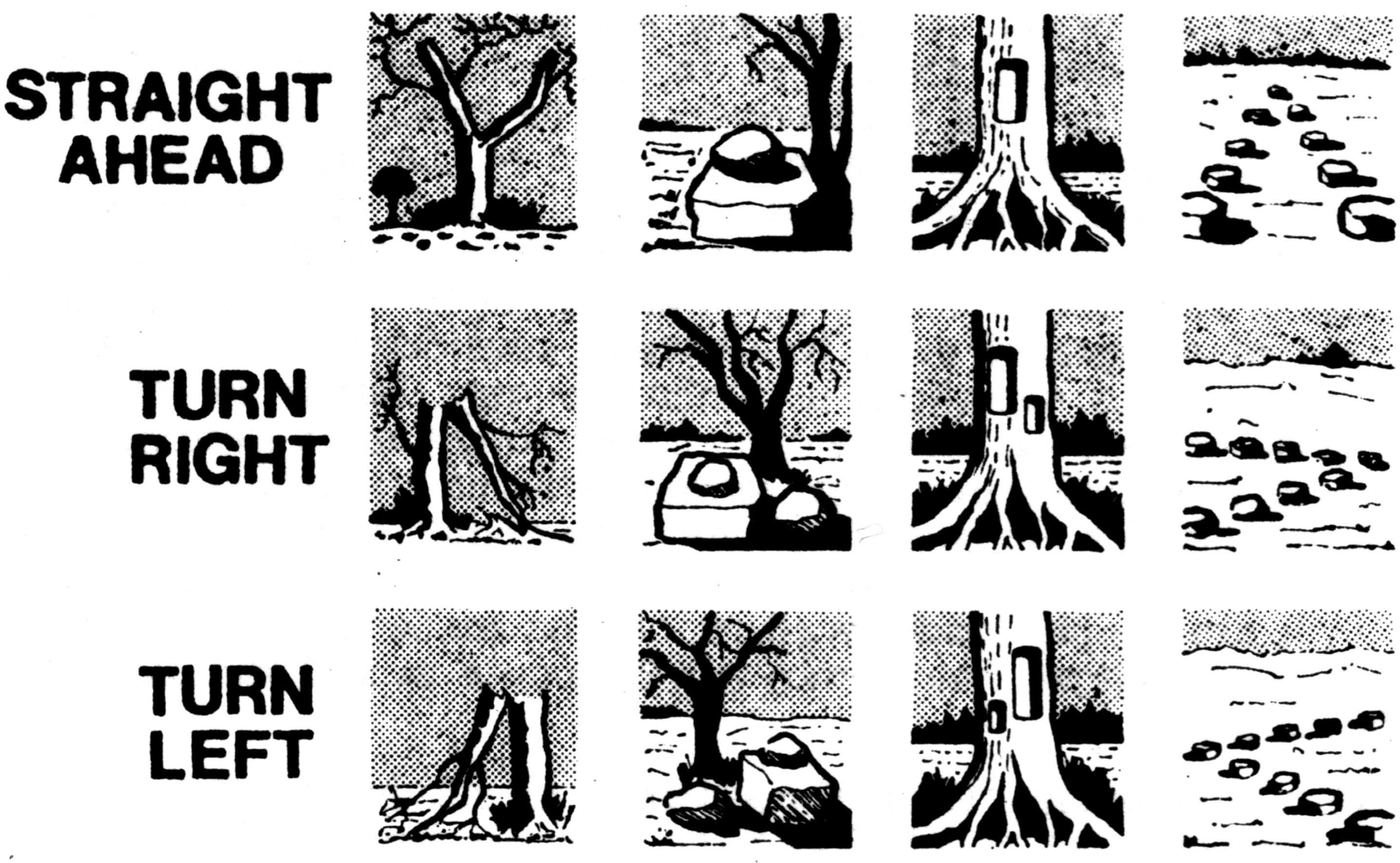


Fig. 45. Trail Blazing

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JUNGLE SURVIVAL

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JUNGLE SURVIVAL

A. M. PAMPHLET 214

ISSUED BY
THE AIR MINISTRY (A.D. RESCUE)

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JUNGLE SURVIVAL

INTRODUCTION

1. There is no standard form of jungle and the word implies either wet tropical rain forest, which is the jungle we usually think about, or dry open scrub country; it refers to any natural uncultivated forest in tropical or sub-tropical lands.

2. Jungle is not constant in composition even in the same climatic zones. Its vegetation depends on the altitude, and, to a large extent, on the influence of man through the centuries. Tropical trees take over 100 years to reach maturity and are only fully grown in untouched primeval virgin forest. This is called "primary" jungle and is easily recognized by its abundance of giant trees 150 feet to 200 feet high and up to 10 feet in width at the base. The tops of the trees form a dense carpet over 100 feet from the ground beneath which there is little light and therefore comparatively little undergrowth: consequently travel is not too difficult in most primary jungle and its animal inhabitants live mainly in the upper branches.

3. Jungle is not all primary. Far eastern hill tribesmen grow one rice crop a year by burning down a suitable area of jungle and planting seed in the ashes which form a natural fertiliser. When the harvest is gathered the tribe moves on to find a fresh jungle area to be burned for next year's crop. In this way one tribe will devastate large areas of primary jungle in a decade. European exploitation has added to the cleared area by felling accessible tall timber along river banks. The cleared area is soon reclaimed by the jungle, but by jungle without tall trees and composed of dense undergrowth and creepers. This is "secondary" jungle and it is much harder to traverse than primary jungle, but it is better for forced landing or parachute descent because of the absence of giant trees.

4. In most far eastern countries, the secondary jungle is greater in extent than the untouched primary jungle. The latter is now found only in the most inaccessible mountainous country or in

areas of forest reserve, preserved by colonial governments for water catchment or other reasons. Don't, however, believe that all the tropics consist of jungle of any sort. Well over half the land is cultivated in some way or other and you will find rubber plantations, tea plantations, coconut plantations, and native allotments. You should learn to recognize these from the air as they are a sure indication of human activities. Remember that neither rubber trees nor coconut palms grow wild in any quantity, and if the plantation is there then the planter cannot be far off. He may only be an isolated Malay but he has to sell his crop somewhere, so he will have good though infrequent contacts with civilization. Remember, too, that rubber trees must be tapped daily to draw off the valuable sap, so that if you get into a rubber plantation you will be found within 24 hours.

5. Primary or secondary, the tropical rain jungle is a difficult and unpleasant land to live in and travel through. The soil is covered with dead and rotting vegetation over which leeches move in countless millions. Numerous other slugs, insects, and small animal life will be found, all in some way loathsome and unpleasant. In low-lying country the ground may be marshy and even under water, with only the trees and their buttressed roots showing the presence of soil below. Close to the ground will be found thick, and, in secondary forests, sometimes impenetrable, undergrowth containing a considerable number of plants, fruits, and vegetables, some edible and some poisonous. Over the undergrowth in primary jungle is the rather more open space beneath the jungle tree tops, with an abundance of all types of trees, creepers, and vines amongst which you will sometimes see animal and bird life. Over all this is the thick jungle top or umbrella through which little light penetrates. Here amongst the tree tops may be found birds, bees, moths, monkeys, and so on. Yet, despite the teeming life of this jungle you may journey for several days and see no sign of it, so timid and shy are the majority of the inhabitants ; and, among all these living things, you may starve if you are not jungle-wise.

6. The dry scrub country is more open than the wet jungle, and prickly-pear, cactus, and leafless cactus-like trees are common amid the thorny brakes and tall grass. It is tiresome to be caught in this country, for its lack of topographical features, population and tracks, make it difficult to find a way out. But patience, a compass, and common sense will do the trick.

7. Despite all the perils and unpleasantness of the jungle, thousands of Englishmen have lived and travelled in it safely for months on end, and hundreds of them have enjoyed it and still do. With a little knowledge you can achieve safety if not enjoyment.

ESSENTIAL CHARACTERISTICS OF THE "JUNGLE HIKER"

8. Whatever the type of country into which you are unfortunate enough to crash-land, or "bale-out", or if after a successful ditching you make a landfall on some small tropical island, your chances of survival and eventual rescue depend on a few definite factors. By far the most important of these is the first, "determination to live" ; but together they will give you the morale to bring you through :—

(*a*) Determination to live.

(*b*) Previous knowledge ; ignorance of a few simple rules on the part of one member of the party is a danger to the remainder.

(*c*) Confidence in your knowledge of jungle and island life.

(*d*) Common sense and initiative.

(*e*) Discipline, and a previously considered plan of action.

(*f*) Ability to learn by your mistakes.

ACTION DURING EMERGENCY

9. The ways of getting into the jungle are baling-out or crash-landing, and the decision will be dependent on the circumstances at the time of the emergency. But whichever course is chosen, on the way down, make a mental note of the following :—

(*a*) The character of the country into which you are going. Consider the relative positions of rivers, lakes, clearings, paddy fields, high ground, ridges, villages, in fact anything which might be of use to you later on.

(*b*) Try to pin-point yourself in relation to one of these, *i.e.* get a mental note of the bearing.

(*c*) If baling-out into thick jungle, it will be vital that you should have some idea of the heading or bearing of the aircraft, or members of the crew in relation to each other, as once "in", it will be found extremely difficult to make contact if you have no knowledge of your relative positions.

To Jump or Not to Jump

10. If the terrain is at all suitable it is normally better to crash-land than to bale-out. However, if you are over mountainous country, or if the aircraft is on fire or out of control, a crash-landing

may be out of the question. To sum up, the advantages of staying with your aircraft are :—

(*a*) The crew is not separated and no member of it will be left alone. This is most desirable from the morale aspect.

(*b*) All the equipment in the aircraft will be available and it will be possible to improvise other essential items from air-frame and engine parts.

(*c*) The fuselage, if intact, provides shelter from animals, insects, and weather.

(*d*) The aircraft or its wreckage is plainly visible from the air.

11. In contrast, baling-out offers only one distinct advantage, that is, the ability to get you down safely on almost any sort of country. However, try not to bale-out over primary jungle if you can avoid it, as you will almost certainly sustain some sort of injury when you land in the tree tops, and you may even find yourselves dangling twixt heaven and earth over a hundred feet from the ground.

12. For the reasons outlined above, if you have to bale-out over a jungle, try to arrange a rendezvous for the crew before you jump. The best rendezvous is your wrecked aircraft and you can decide on that action before you even take-off on a flight.

FORCED LANDING GROUNDS— SUITABLE TERRAIN

13. The jungle does not offer much in the way of forced-landing areas, but if you have any choice or time to make a selection, consider the areas mentioned below, in order of preference :—

(*a*) Beaches.

(*b*) Clearings.

(*c*) Paddy fields—land along the "bunds", *i.e.* banks of mud dividing the fields.

(*d*) Lakes and rivers.

Do not land on tree tops—if it has to be the tree tops, bale-out if there is the height and time to carry out the drill, with due consideration to all those in the aircraft.

IMMEDIATE ACTION ON LANDING

14. The planning of a standard procedure is essential to the ultimate success of the incident, and the following immediate actions should be carried out after landing. This procedure or

drill is, of course, subsequent to the normal crash landing drills, precautions against fire, etc. :—

(*a*) ***First Aid.*** Administer immediate first aid to the slightest scratch. In hot and tropical climates the risk of poisoning from an open wound is very great.

(*b*) ***Fix Position.*** You cannot decide on a reliable plan of action until you have decided just where you are. You may not be able to fix your position to the nearest mile, but you must be able to say "I am within this area". If the aircraft is intact, use the sextant, chronometer, and altimeter to help fix your position.

(*c*) ***Rendezvous if Scattered.*** The place for rendezvous after parachute landing should normally be the wreckage of the aircraft. If the captain has sufficient time before ordering his crew to jump, he may decide to rendezvous at some geographical landmark. If so, he must ensure that all the crew know and can recognize the point of rendezvous and that the landmark is prominent, *e.g.* the confluence of two rivers.

(*d*) ***Establish Two-way Radio Contact if Possible.*** If the aircraft radio equipment is intact, try and contact the outside world on W/T or R/T. Erect an emergency aerial if necessary and run one of the engines to maintain power if you can do so without risk of fire.

(*e*) ***Prepare all Signalling Gear for Immediate Use.*** You will not have time to prepare signalling fires, etc., if you wait until you see aircraft searching for you. Have fires lighted in readiness for the search aircraft and keep oil and petrol near the fires so that you can produce a dense column of smoke at short notice. The petrol will make a rapid flare-up by night. Consider what steps can be taken to make the scene of the incident more noticeable from the air. Make a clearing for the display of ground signals (see page 68), or move to a clearing nearby if you can find one. Spread out parachutes and polished aluminium panels to reflect the sun. Try and evolve signalling methods which will show above the jungle top, *i.e.* smoke columns or parachutes spread over the trees.

(*f*) ***Check Emergency Equipment, including Rations.*** Check the survival equipment available from your personal kits and emergency packs. Examine the other equipment in the aircraft and decide what will be of use to you, *e.g.* fire axe, compasses, parachutes, etc. Drain-off supplies of

petrol and oil for signalling purposes, check all available rations and water supplies. Try and repair any unserviceable or faulty equipment.

(g) ***Institute Immediate Rationing.*** No matter how much food and water you have, you should attempt to conserve it as long as possible by rationing. Do not cut the water ration below one pint per person per day unless in dire emergency. If food and water supplies from the aircraft are scanty, take immediate steps to implement them from natural sources. Don't leave it until you are too weak before you begin to hunt for your meals. If you can get food and water locally do so, and reserve your emergency rations for a real emergency.

(h) ***Elect a Leader and Delegate Duties.*** Normally the captain of aircraft will act as leader, but in special circumstances another member of the crew may be better suited. The captain may be injured, or one of his crew may be a jungle expert. In any event make a decision and stick to it. Each member of the crew should be given a special job, *e.g.* cooking, collecting water, building shelters, preparing signal gear, collecting edible plants, etc. Boredom and apathy can be dangerous to an idle man.

(j) ***Relax and Formulate a Plan of Action.*** After you have checked your equipment, don't be in too much of a hurry to start on "trek" towards the nearest town. There may be very good reasons for staying with the aircraft and there is plenty of time for careful thought. Assume from the start that you are in for several days in the jungle and another 24 hours either way will not make much difference. A good night's sleep in a well constructed jungle camp will make all the difference to a shaken crew. *Do not* relax if you have force-landed in enemy territory.

PLAN OF ACTION

15. If in wartime you have landed behind enemy lines, you must leave the scene of the crash at once. It may be advisable to split a large crew into parties of three or four men than to travel together. Once you are well clear of your crashed aircraft, set course for the nearest allied or neutral territory.

16. In peacetime or in friendly territory you must decide whether it is better to stay with the aircraft wreckage or to set out towards the nearest civilization. You may even decide to split the crew and leave some men with the aircraft while others go for help.

The main consideration is: *Are search aircraft likely to find you in less time than it will take to walk to civilization?* Once you start on "trek" there is little likelihood of your being seen from the air.

17. Once you have come to a decision based on careful consideration, put it into effect at once and stick to it. Your mental processes will be strained after several days in the jungle and you may later be tempted wrongly to abandon a good plan before it has had time to mature. Persevere and you will be successful.

18. Factors on which to base your decision are:—

(*a*) Do the authorities know that you have force-landed and do they know the position of the incident? If so, you will soon be found if you stay with the aircraft.

(*b*) If your position is not known, were you on track as per flight plan at the time of the crash? If you are missing, the first search will be along this track.

(*c*) Is the aircraft wreckage easily visible from the air? Can you make it visible?

(*d*) Have local forces sufficient aircraft at their disposal for an effective search; have the aircraft sufficient range to reach you?

(*e*) Is the weather favourable for search aircraft?

(*f*) Are transit or other aircraft likely to fly over your position? If so, how frequently?

(*g*) Do you know your own position accurately? If so, are you in easy reach of any known human habitation? Is the country between it and your present position easy to traverse? How long will the journey take you?

(*h*) Are all the crew fit for a journey through the jungle? Is any member so seriously injured as to need immediate medical aid? In the latter event, it may be advisable to send one party off for help while others stay with the injured man.

(*j*) Have you good supplies of survival equipment for a long march through the jungle: compasses, matches, etc.?

(*k*) What are your supplies of food and water? Consider the supplies available from aircraft emergency packs and those obtainable from natural sources. Is there a good water supply near your wrecked aircraft? Will you be able to live off the jungle when your emergency rations are expended?

(*l*) Lastly, how much do you know about jungle survival? If you have little confidence in your knowledge, stay where you are.

19. If you decide to remain with the aircraft you must ensure that every possible means of attracting attention is ready for instant use. Sound does not travel through thick jungle vegetation, so you can expect little warning of an approaching aircraft, and should one come within range the opportunity must not be lost. See that you are prepared and try to erect as many permanent indicators as you can.

(*a*) ***Permanent Ground Signals.*** Parachute canopies spread out preferably over tree tops or in open clearings. Yellow dinghies inflated and placed in clearings. Bright panels or cowlings spread out near the aircraft, broken glass, the aerial kite flown above the tree tops, white clothing spread out on a line.

(*b*) ***Distress Signals.*** Flame fires using petrol or dried wood by night; smoke fires, using oil or damp leaves by day; (keep fires lit all the time if the local wood is damp and fires are difficult to light); pyrotechnics; and fluorescence in streams.

20. If you intend to leave the aircraft you must first decide how much equipment to take with you. Don't take too much as you will soon find it heavy and cumbersome. Take such items as parachute canopies, for tents and hammocks; shroud lines for ropes, etc.; personal survival kits, first aid kits, fire axes and food and water. If you have not all got tropical back-packs a good container can be made from the parachute pack by cutting away surplus webbing. Another method of carrying equipment is to sling it on a long pole carried between the shoulders of two men. Don't discard too much clothing when setting out on "trek". The jungle is cold at night and you will need protective covering against mosquitoes and leeches, etc. Gloves are invaluable for clearing away thorns. When you leave the aircraft wreckage display a prominent notice saying where you have gone, and spread out the appropriate Ground Air Emergency signal.

JUNGLE HAZARDS

21. The large majority of people have an entirely erroneous impression of the risks and dangers involved in jungle travel. The majority think immediately of the big game, snakes, and other reptiles; so it must be made perfectly clear, that though the wild animals may abound in jungle country, they are as much concerned about keeping out of your way as, no doubt, you will be about keeping out of theirs. Where then are the dangers, from what source, and direction?

22. The greatest dangers lie in the demoralizing and cumulative effect of sometimes rather insignificant factors, which may be summarized under the following headings:—

(*a*) Panic.

(*b*) Sun and heat, and sickness therefrom.

(*c*) Sickness, and fever—malaria, dysentery, sand-fly, typhus—are some of the more common.

(*d*) Demoralizing effect and danger from all forms of animal life.

(*e*) Poisoning, by eating or contact with plants. (See paras. 99 and 100.)

Most of these hazards are avoidable by taking precautions as provided by Service medical treatment, plus an elementary knowledge of personal hygiene.

Effects of Sun and Heat

23. The sun is highly dangerous because the effects are so frequently ignored. It causes sunstroke—or heatstroke—sunburn, and what is often referred to as heat exhaustion.

24. Sunstroke may occur at any time, day or night; the victim becomes feeble and giddy, his throat is dry, he suffers from thirst, his skin becomes cold and clammy, the pulse increases and weakens, his temperature rises, he appears flushed, and he vomits. Move the victim into the shade, where there is a free circulation of air, strip to the waist and place in a sitting position on the ground. If possible spray cold water over the head and back, and give the victim ice or cold water; as the temperature falls cover him with a blanket, and ensure he remains in the shade.

25. The prevention of sunburn is much easier than its treatment; remember this when in the tropics. Many people become severely burned because they fail to realize that the effects of sunburn are not felt until too late; that is, when you notice your skin turning pink, or feeling hot. When hazy or overcast, danger from sunburn is greater, as it is even less noticeable, there being so much reflected light. Should sunburn affect more than two-thirds of your body, it is likely to prove fatal. Therefore go carefully, take the precaution of keeping out of the sun as much as possible, and allow your skin to tan slowly, after which the dangers from sunburn are somewhat reduced.

26. Heat exhaustion is caused from long and continuous exposure to heat with high humidity, and may occur without direct exposure to the sun. The skin becomes cold and clammy with sub-normal temperature; the only cure is to get into the shade, and cover yourself to avoid becoming chilled, taking plenty of water and salt. Salt tablets should be taken daily if you have an ample supply of water available. Don't take them if water is scarce, as they will increase your thirst.

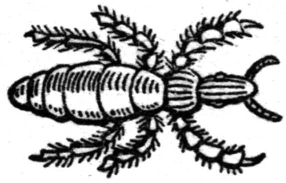
Sickness and Fever

27. ***Malaria.*** This is caused by the bite of an infected mosquito and the fever occurs at regular intervals after the first attack. As it begins the victim feels chilly and shivers; later in the attack he feels a burning fever. The hot and cold fevers alternate throughout the illness. Malaria may be prevented or minimized in two ways: by taking mepacrine consistently, and by avoiding mosquito bites. The latter course entails wearing long-sleeved coats and long trousers at all times. The jungle mosquito does not bite only by night, as the jungle is always protected from direct sunlight. The treatment for malaria is rest, copious drinks of water, and strong doses of mepacrine, six to eight tablets per day, until the attack is over. Once the temperature falls the patient can continue working or marching but there may be minor after-effects for some days.

28. ***Dysentery.*** Caused by eating or drinking polluted food or water. There are two types, but both have the same symptoms which are severe inflammation of the bowels and abdominal pains, and severe and continuous diarrhoea accompanied by green and bloody faeces. To prevent dysentery see that all doubtful food is cooked and all water purified. Be particularly careful near native villages where the vegetables, etc., are often fertilized with human excreta. To treat dysentery, sulphaguanadine is supplied in the tropical first-aid kit. Routine treatment is to put the patient on a soft liquid diet of milk, boiled rice, coconut milk, boiled bread, etc. The patient should take plenty of boiled water. Ordinary diarrhoea, which may be mistaken for dysentery, is often caused by stomach chills at night. To avoid chill, wrap a towel or cummerbund around your stomach when you go to sleep no matter how hot you feel.

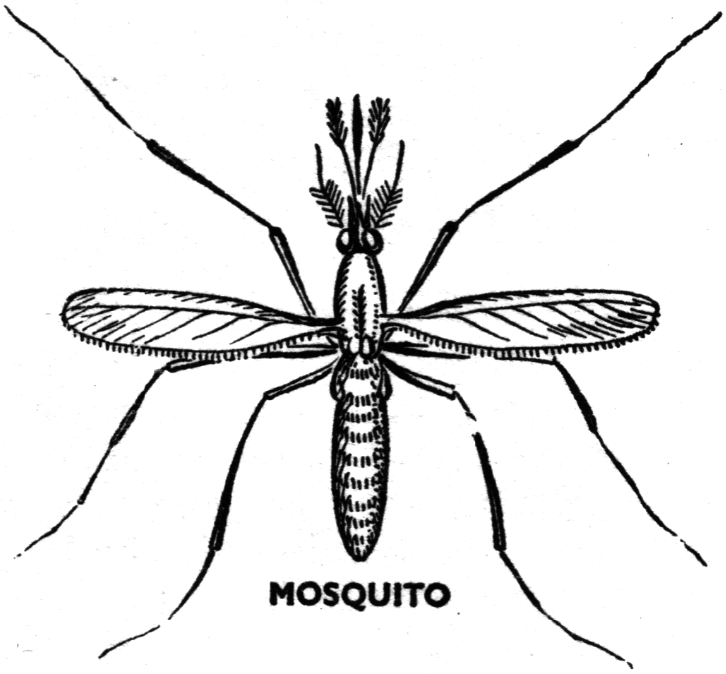
29. ***Sandfly Fever.*** Caused by the bite of the sandfly and has symptoms similar to malaria. To avoid the fever don't get bitten. Treatment as for malaria.

30. ***Typhus.*** Usually caused by the bite of an infected louse or a tick. The symptoms are a severe headache, weakness, fever and aching, the victim's face turns dusky, the tongue and lips become coated with a brown fur and on the fifth day the skin becomes



BODY LOUSE

SANDFLY



MOSQUITO

mottled and covered with a bright pink rash. Typhus is likely to prove fatal without medical attention. It can be avoided by regular innoculation and by personal cleanliness. Ensure that all ticks are removed from the skin and check clothes daily for lice ; wash the body at least once a day.

Danger from Forms of Animal Life

31. The forms of animal life differ in various parts of the world and a certain type might be dangerous to man in one part and not in another. The most deadly form of animal life is the mosquito which is found all over the world in different forms, but it can only be dangerous in certain areas.

32. ***Mosquitoes.*** The anopheles mosquito carries malaria and is a menace against which every precaution should be taken.

(*a*) Always wear a mosquito net and leave no part of the body exposed.

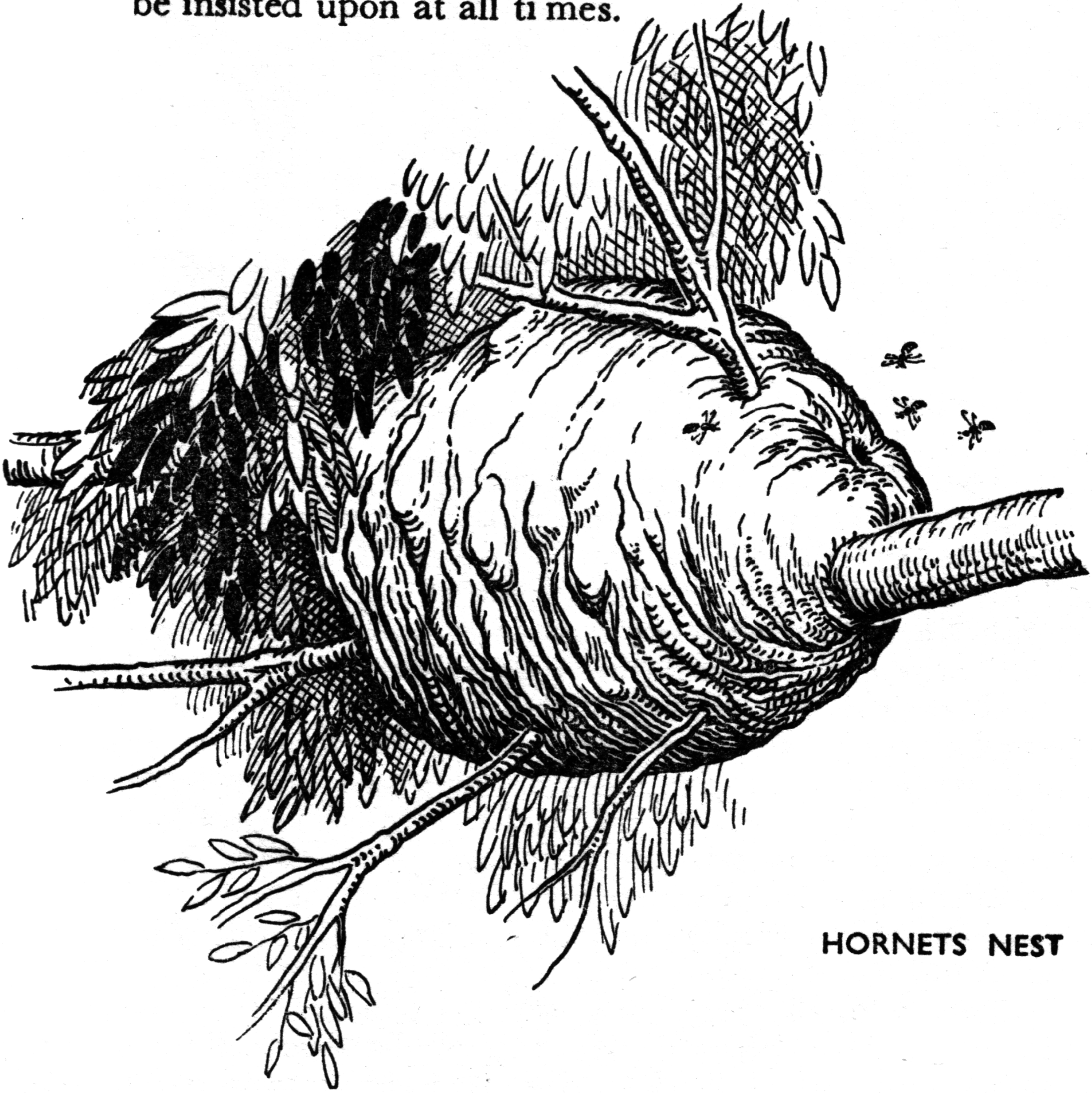
(*b*) If you have no mosquito net, a handkerchief, parachute canopy or large leaf can be used as a makeshift.

(*c*) At night in particular, but at all times if possible, have trouser legs tucked into the tops of your socks, and shirt or tunic sleeves into gloves.

(*d*) When encamped, have at all times a smoky fire burning and sleep to leeward of it.

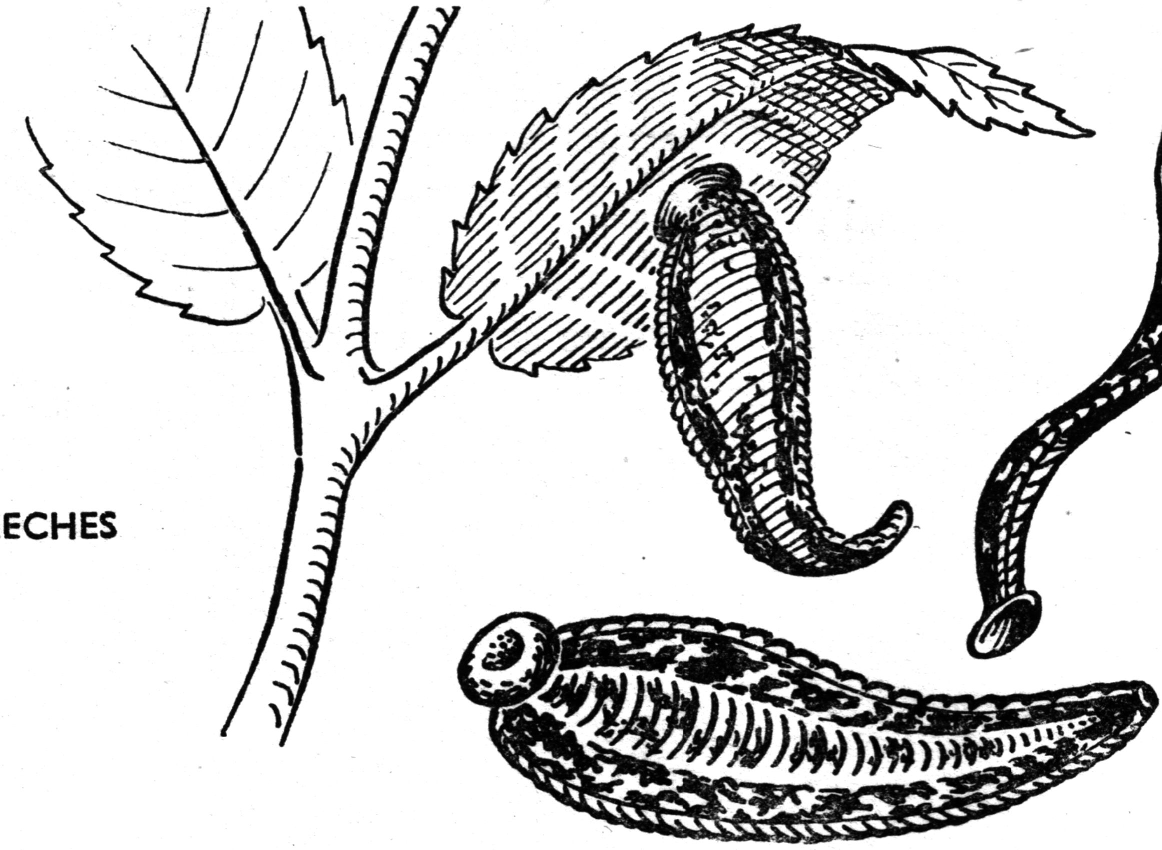
(*e*) Keep away from swampy and stagnant areas when resting or camping in the jungle, for these are the mosquitoes' breeding ground.

(*f*) There is no preventive innoculation against malaria, so very strict observance of these anti-malarial measures must be insisted upon at all ti mes.



HORNETS NEST

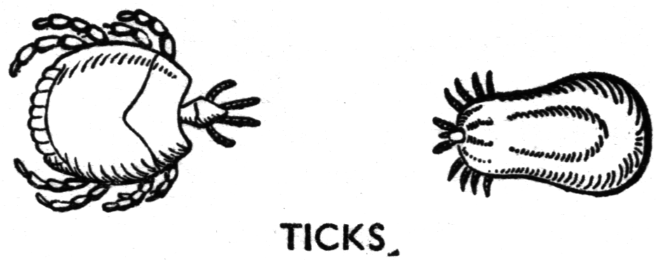
33. ***Wasps, Bees and Hornets.*** These are dangerous pests. Their nests are generally brownish bags or oblong masses on trunks and branches at a height of 10-30 feet, and often on dead standing trunks. If a nest is disturbed and you are some yards away, sit still for five minutes and then crawl carefully away. Wasps go for moving targets, but should you be attacked, run through the bushiest undergrowth.



LEECHES

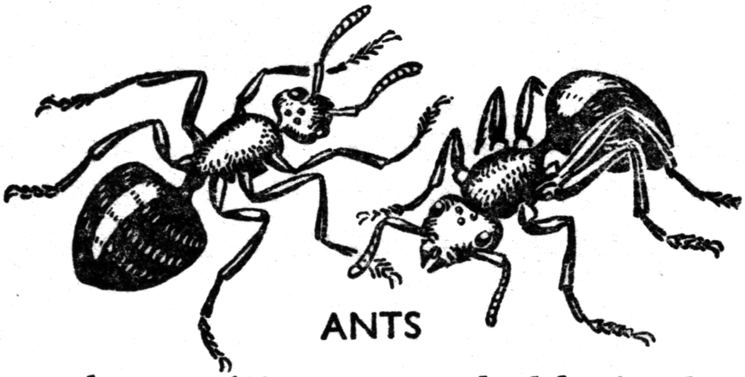
34. ***Leeches.*** Never pull them off, as their jaws will remain in the bite, and possibly fester and irritate. When moving through the jungle, if smoking, keep the pieces of unburnt tobacco, and wrap them up in a piece of material. When de-leeching, moisten the bag so formed, and squeeze the nicotine onto the leech. Other methods of de-leeching are the juice of the raw lime, salt, ash, and ash from a cigarette-end, or pipe. By using these methods, you force the leech to withdraw its jaws from the flesh and to drop off, with no risk of infection. Leave the blood clot on the leech bite as long as possible, squeezing it slightly at first to ensure the wound is clean, and the bleeding will stop in a few minutes. Leeches abound in lowland forest after rain, so keep a look out for these pests, and inspect your legs and boots every few minutes, and flick off any leech which has not yet got a hold. The large horse-leech will normally be found only in the sluggish lowland streams and swampy forest.

35. ***Ticks.*** Small grey ticks cause irritation, they swarm on plants or on dead fallen trunks, and might swarm onto a person in great numbers. Found during the wet season, ticks should immediately be removed from clothing, by hanging over or to leeward of a smoky fire; in the same way if ticks are on the body they can be smoked off. Remember also, when dealing with dead game, that ticks thrive on game, and especially on wild pig.



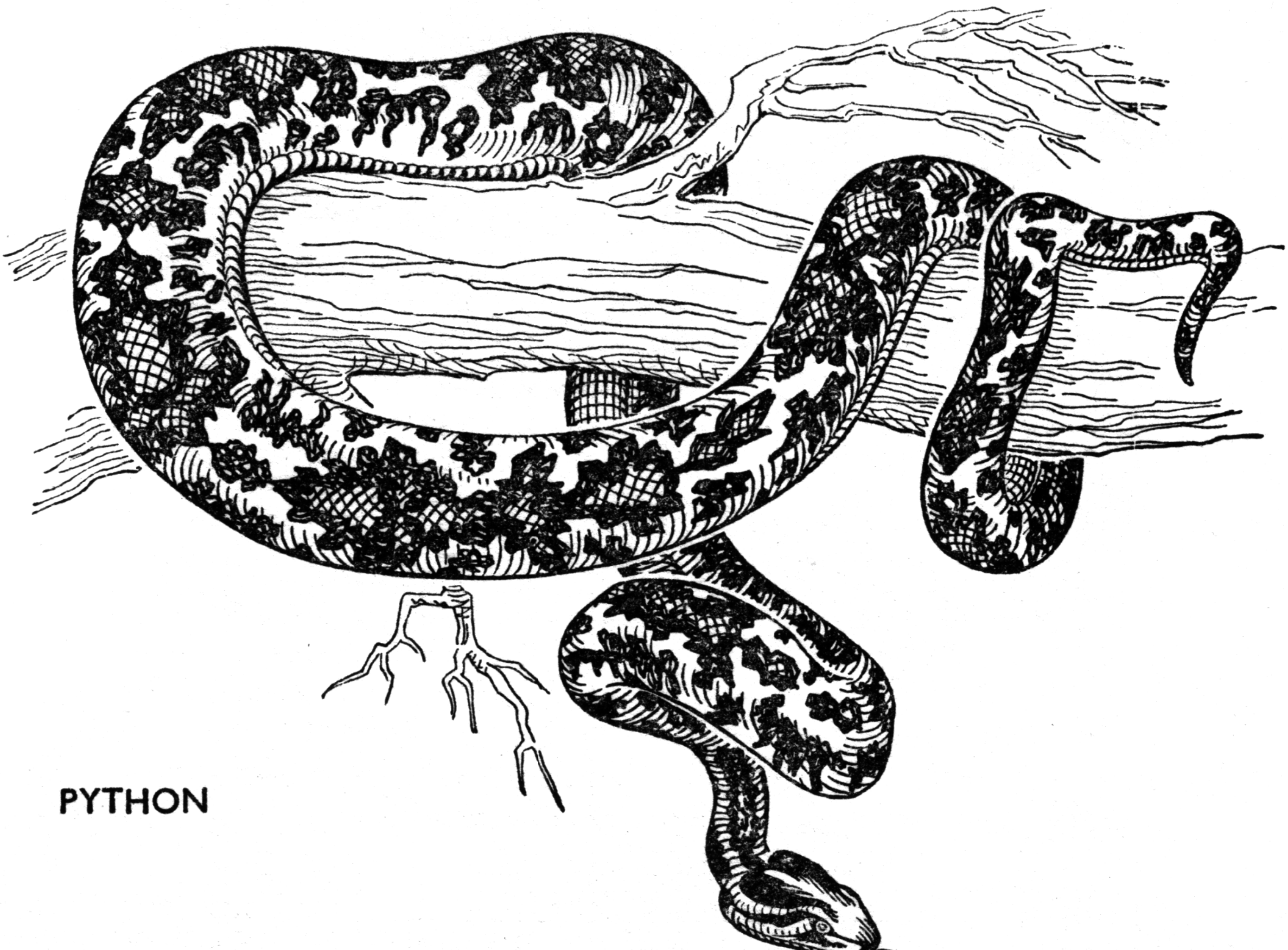
TICKS

36. ***Ants.*** The Red Ant makes its nest on the twigs of trees or shrubs, and is persistent in its biting attacks ; other smaller biting ants have nests like earthy lumps, and it is wise to avoid trees with such apparent growths on them. Trees seen with leaves clumped together into small masses, or those on which ferns and orchids grow should also be avoided, as these will most probably harbour the biting ant.



ANTS

37. ***Snakes.*** Even the most deadly snakes prefer to glide away at the approach of man ; but watch out for alarming one, or cornering it, particularly if following animal tracks, where they are found motionless on the ground, blending with their surroundings. Details of some of the snakes to be found in the jungle are given below :—



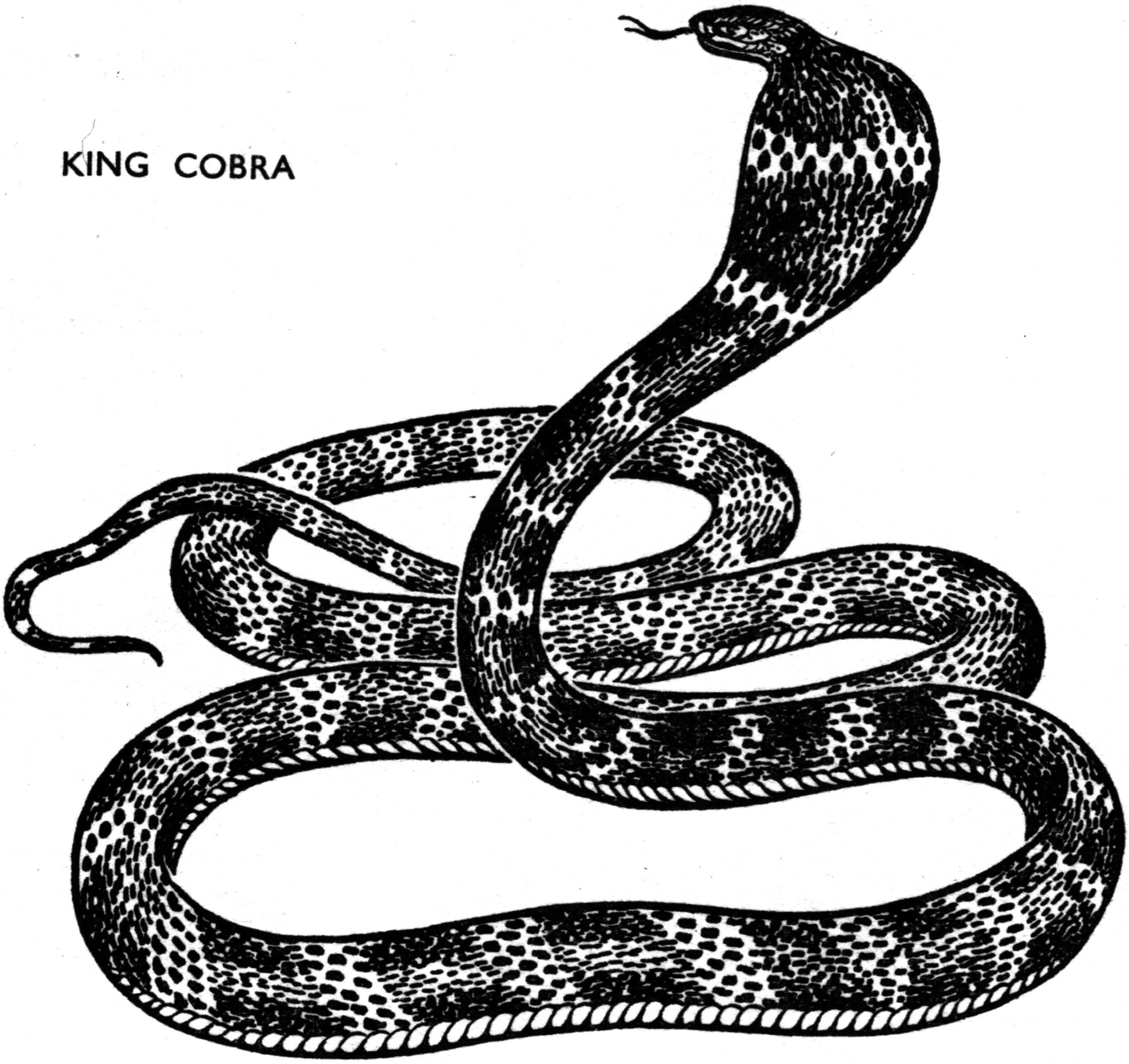
PYTHON

(*a*) ***Python.*** Length up to, but usually well below, 20 feet. A large constricting snake, sluggishly active by day and night. It prefers the forest, and may be found on the

ground, up trees, or in the water. It is not of a timid nature, but though of very great strength, makes no attempt to avenge injury or offence. Has rarely been known to attack human beings.

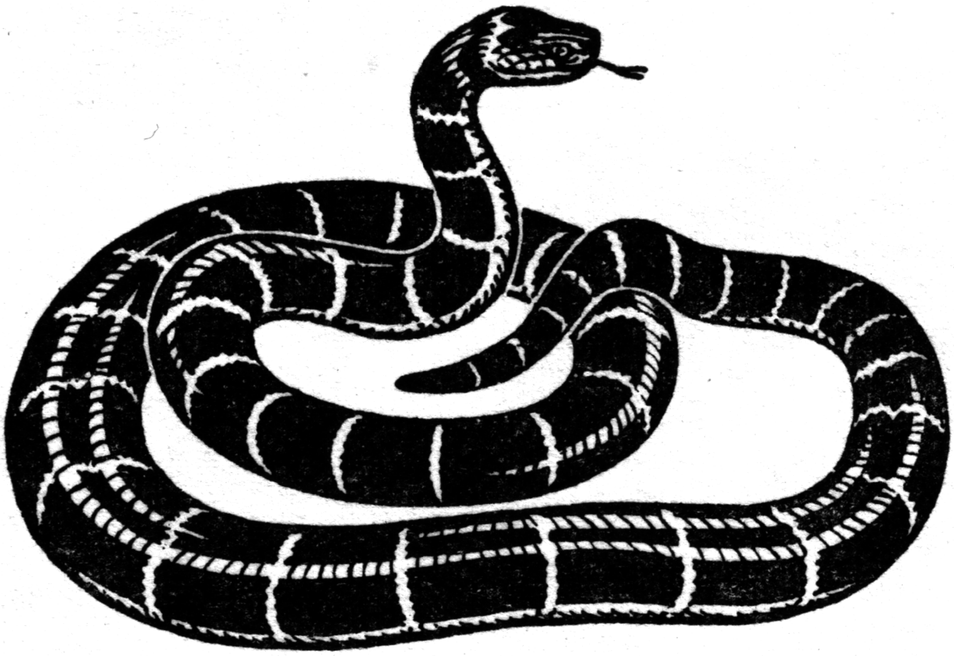
(*b*) ***Hamadryad or King Cobra.*** The largest of all poisonous snakes and is said to be the only one which will deliberately attack a man. It is olive or a yellowish brown in colour

KING COBRA



and may have a length of up to 18 feet. It is found in India, Malaya, South China and the Philippines. It is very aggressive and its bite is dangerous.

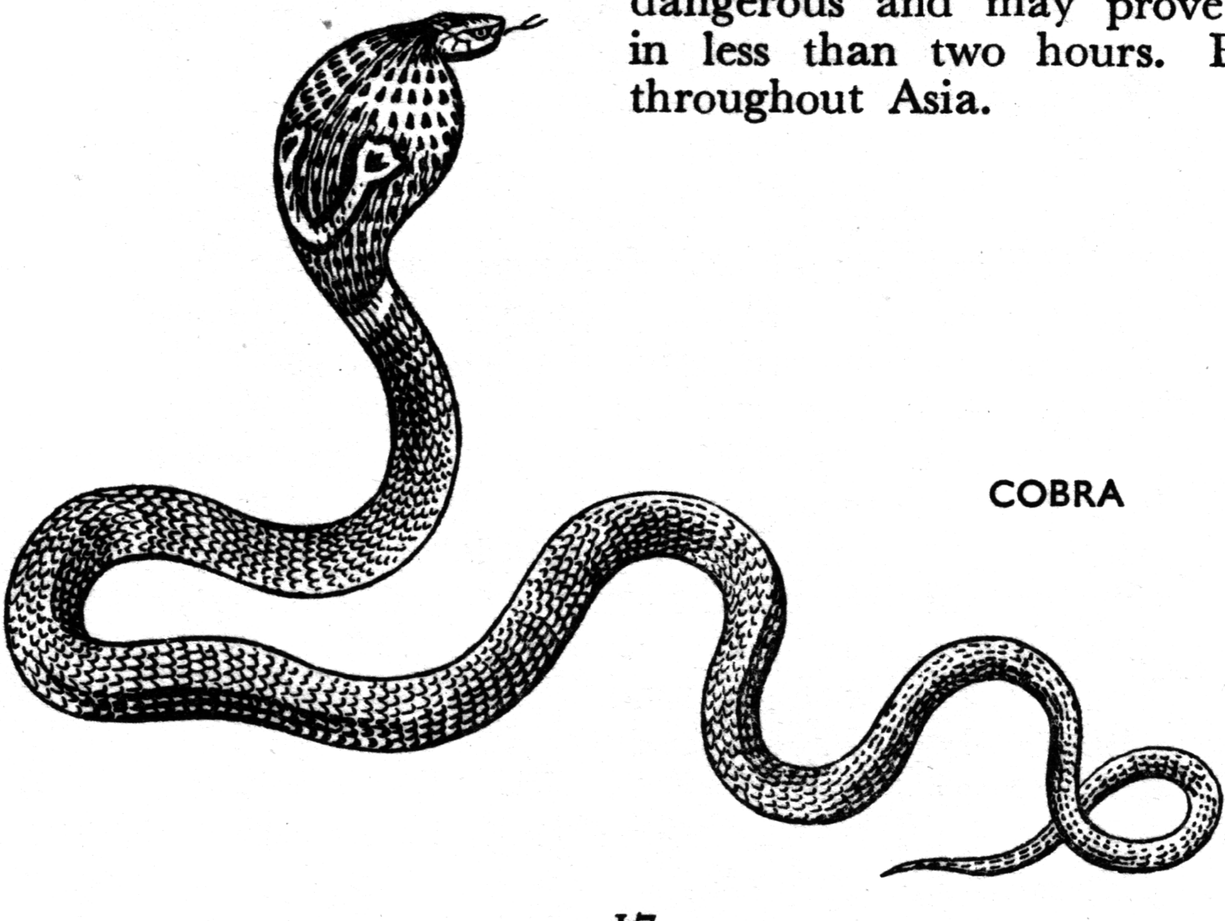
(*c*) ***Krait.*** Length about 3 feet, colour glistening black with narrow white cross bars. It lives in fields, grass, paddy and low scrub jungle and is found in India, Malaya and South China. Its bite is lethal, but it will seldom attack even under provocation.



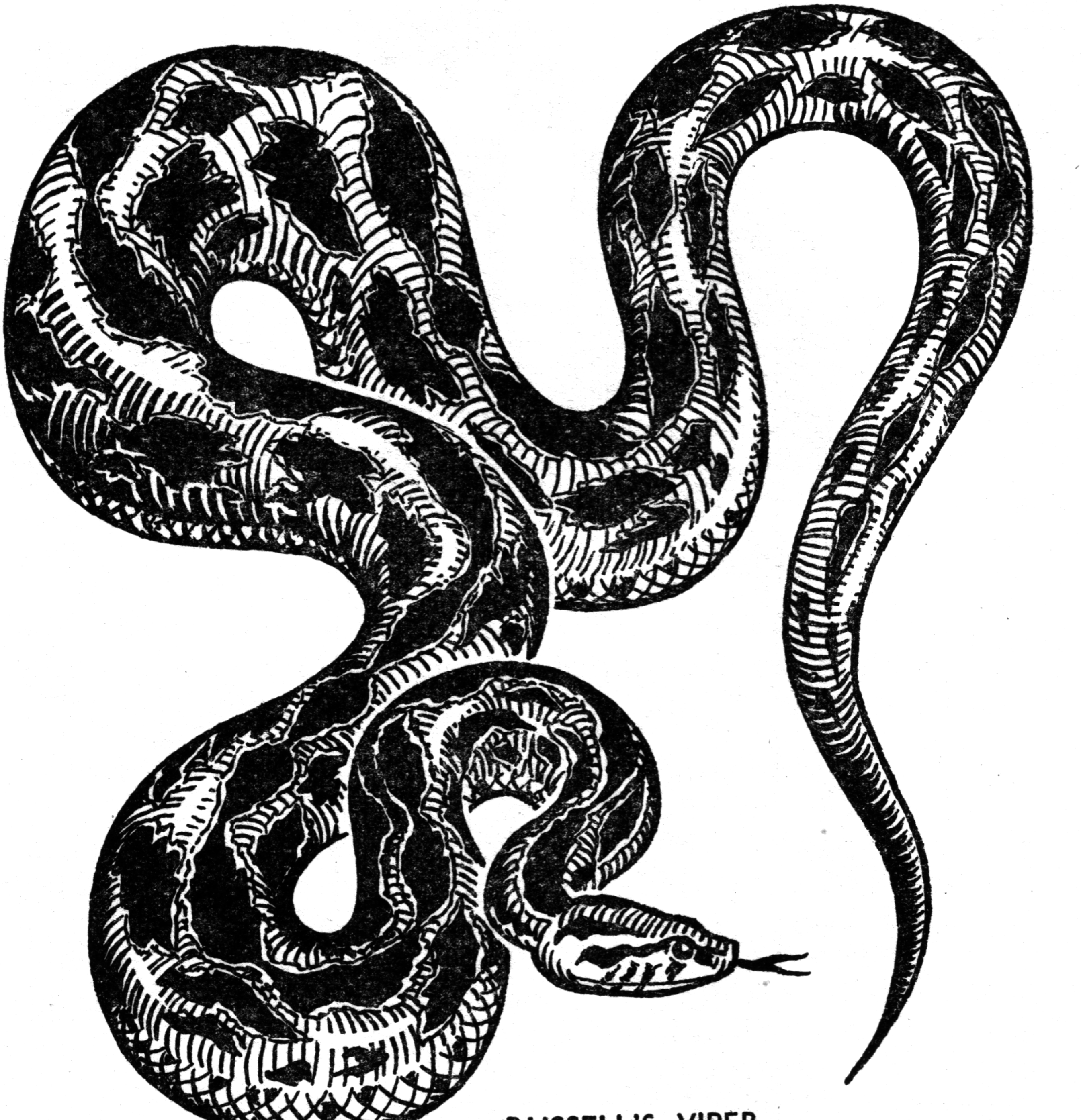
KRAIT

(*d*) ***Banded Krait.*** Colour black with broad yellow bands. Is found in the same countries as the ordinary krait, but prefers wet jungle areas. Not aggressive.

(*e*) ***Cobra.*** Length 5-6 feet. Its colour varies from pale brown to black. It has spectacle-like markings on the upper surface of the neck which are best seen when the hood is distended. It is most active by night, but will only attack man if disturbed or frightened. The bite is dangerous and may prove fatal in less than two hours. Found throughout Asia.



COBRA

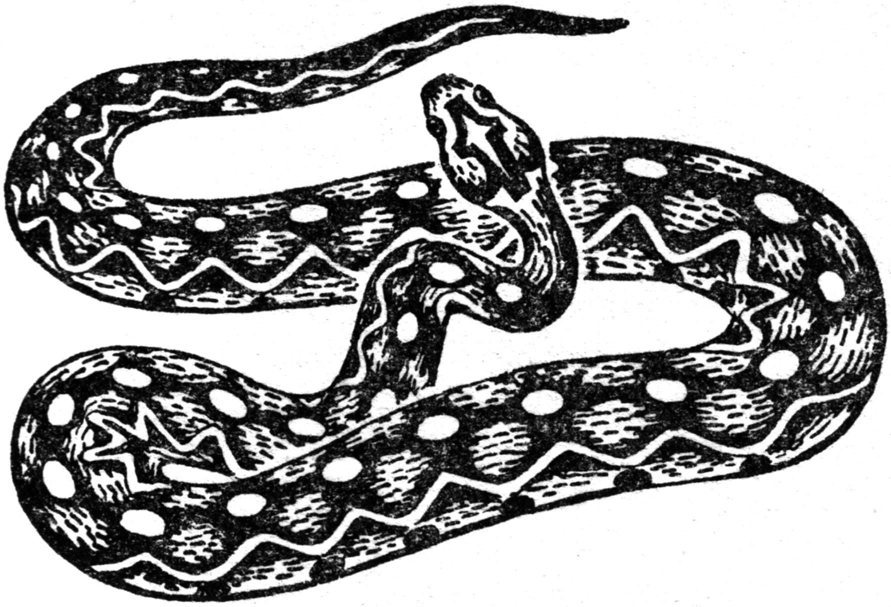


RUSSELL'S VIPER

(*f*) ***Russell's Viper or Tic-Polonga.*** Length up to 4 feet, dark brown in colour with three longitudinal series of black rings. Its underside is normally white or pale yellow but is sometimes mottled brown, the head is large and ugly and is covered with symmetrical dark markings. It is nocturnal in habit, usually sluggish but violent when roused. It is particularly dangerous in that, because of sluggish nature, it fails to get out of the way, and when attacking it can jump its own length. Its bite may be fatal in 24 hours. Found throughout South East Asia.

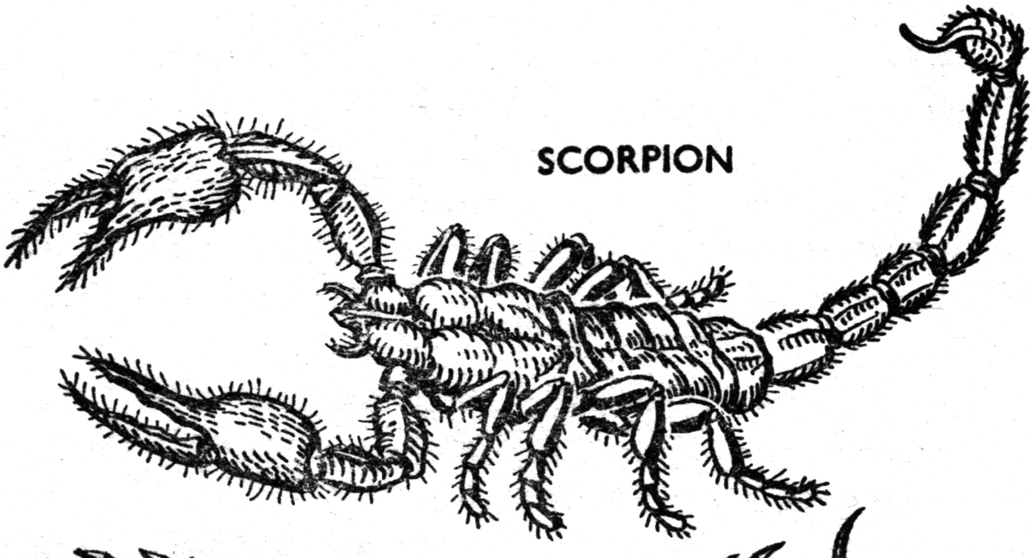
(*g*) ***Hump-nosed Viper.*** Length about 30 inches. Its habits are similar to those of the Russell's Viper, but its bite is seldom fatal. Generally found under dead leaves and undergrowth.

(*h*) ***Saw-Scaled Viper.*** Found in dry sandy areas where there is little vegetation. Its length is about 2 feet, and it is sandy yellow in colour with darker spots. It is aggressive and very poisonous. It may be found in the full blaze of the sun or beneath hot stones and in crannies heated by the sun. It has a habit of lying in a figure of eight with its head in the centre. Found in Syria, Persia and India.


SAW-SCALED VIPER

(*j*) ***Sea Snakes.*** Found around the tropical shores of the Pacific and Indian Oceans and in river estuaries. They do not frequent deep water. All sea snakes are poisonous but are seldom known to have attacked bathers. 2-4 feet long.

38. ***Scorpions and Centipedes.*** Although common in the tropics they are seldom seen in the open. They may be found under the


SCORPION


CENTIPEDE

bark of fallen tree trunks and under stones or rocks. Neither scorpion nor centipede will normally attack unless molested, but take care when handling rotten vegetation or when moving rocks. Inspect your boots before you put them on, as scorpions like to hide in discarded footwear.

39. *Sandflies.* Abundant by rivers, old forest clearings, and on sea shores. Take precautions as for mosquitoes.

40. *Big Game.* Most big game will avoid the scent and sound of man. If you travel noisily everything else will get out of your way. At night and in camp, keep a fire going to scare off wandering animals. Wild elephants may be inquisitive but will not approach a fire or light. Tigers are only dangerous when old and confirmed man-eaters. Avoid the banks of rivers, waterholes, and game trails by night and look out for crocodiles in the water at all times. Throwing stones is supposed to drive off crocodiles but you may not care to trust this.

JUNGLE TRAVEL

41. It is not generally possible to travel direct across country through the jungle. Your choice of paths will normally be restricted to streams and rivers, dry water courses, game trails, native paths, and along crests of ridges. These are the jungle highways and they have one thing in common—they run parallel to or follow the tilt of the land. Few jungle tracks cross from one valley to another or traverse a series of crests ; rather they run along the valleys or along the ridges separating the valleys. If there are no paths or streams, etc., and you have to cut across country, you may be able to make headway, but only at less than one mile per hour. Even a track 25° off your required bearing is better than no track at all. In jungle country you may find difficulty in reconciling the map and the compass. If in doubt, trust the compass, as jungle paths change position frequently and even rivers change their courses.

42. Tracks, game trails, streams, and ridges are animal highways at night, so keep clear of them in the hours of darkness.

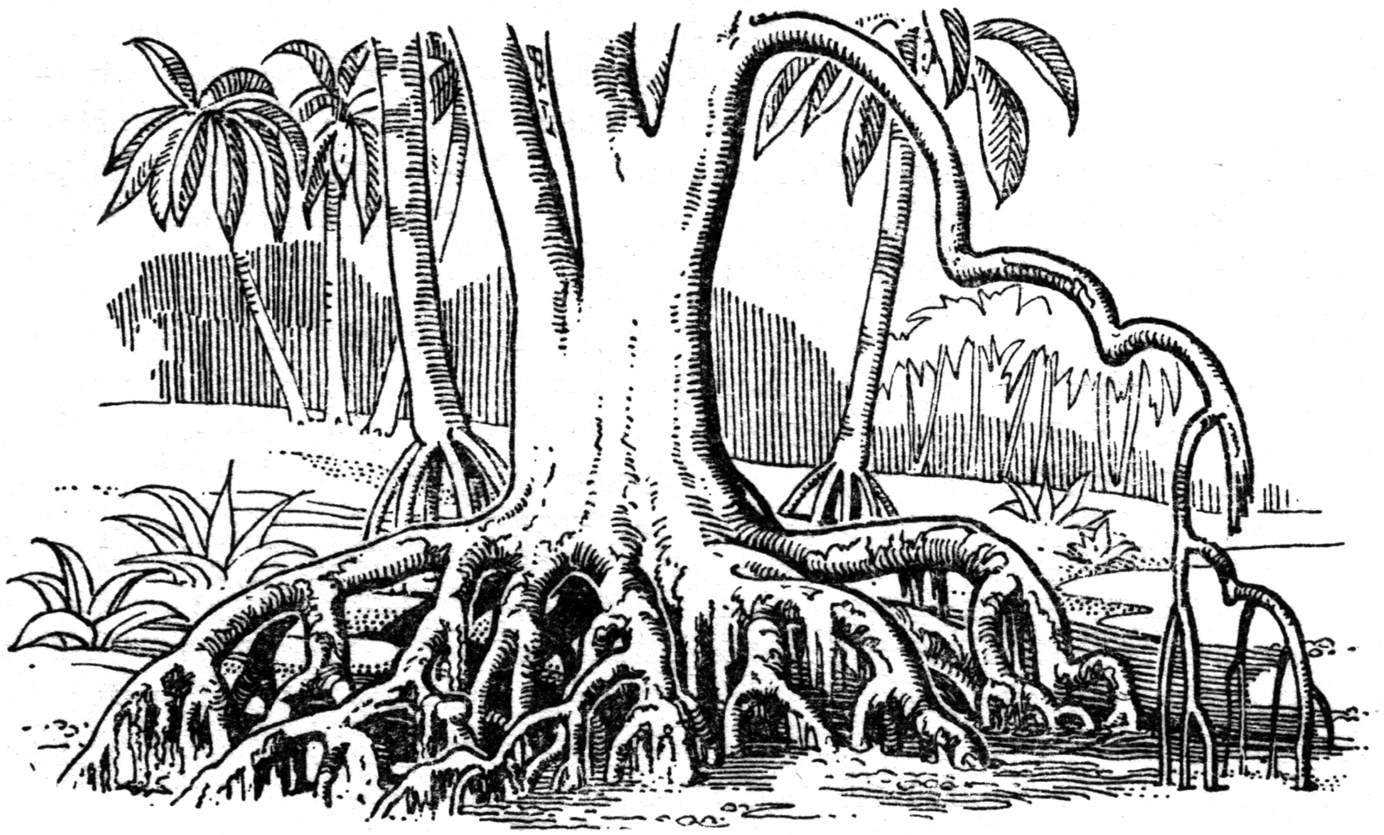
43. To reach human habitation, follow down the course of a river or stream. Native villages are invariably sited on the banks and at the confluence of rivers which are the natives' trade routes.

44. If you wish to leave your camp site and later return to it, mark your trail. Blaze trees to show the white wood as you proceed, or cut off palm leaves and turn them upside-down to show their lighter undersides. Stones and broken branches will also mark a trail.

BLAZE TRAIL

45. If you are without a compass, follow a stream or river and do not attempt to strike across country. If you have a compass, use it constantly and maintain direction by sighting on a landmark ahead on your required bearing. Make for this landmark and then consult the compass again.

SPLIT ROOTS



46. If you wish to attract attention, do not wear yourself out by shouting. Hitting the trunk of a tall tree with a stout stick will make a drumming noise which carries much further than the voice.

47. In the lowlands trees with split roots will indicate swampy and perhaps tidal ground. Avoid all swamps, particularly mangrove swamps. The going is almost impossible and you are likely to get stuck half-way and have to turn back.

48. Never rush blindly forward. Whenever possible go slowly and deliberately, looking well ahead for hornets' nests, etc. Look out for snakes lying in the path. If you are in a party, travel in single file and have a "slasher" with a machete or knife in the van.

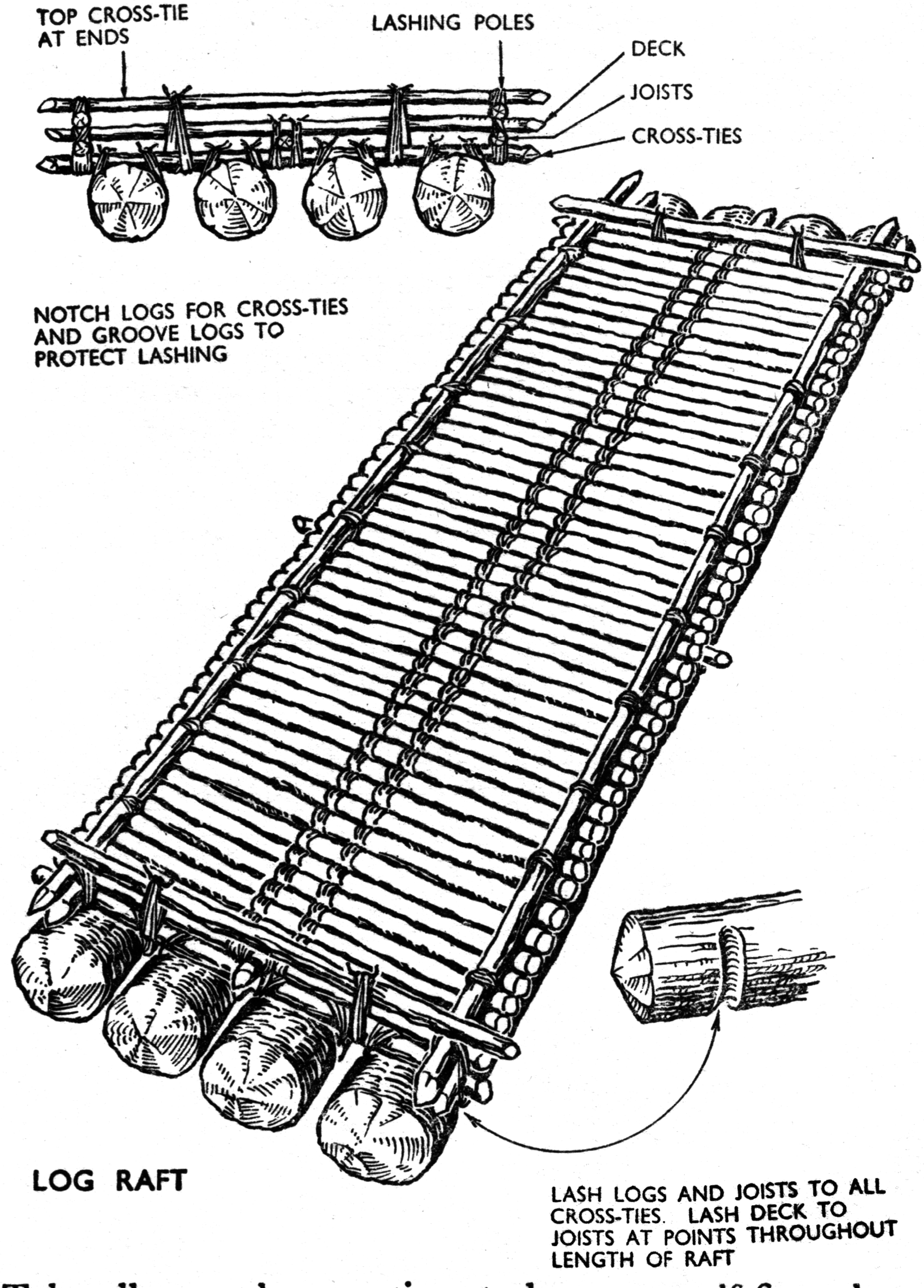
49. Do not tread or sit on rotten trunks or tree stumps, as they often harbour ticks. For the same reason avoid the wallows of large animals and wild pig. Never hit any dead or decaying vegetation without looking upwards. Dead branches may fall on you if you do not look.

50. In steep gullies or on hillsides there is often an accumulation of boulders and tree roots which become covered with mould and moss and form a false ground layer. Beware of breaking a leg by falling through this.

51. If you have no compass, you can judge direction by the sun, but you can only do so with accuracy in the morning and evening. At midday in the tropics the sun is so high that it is useless as a directional aid and you cannot find the North Point from your watch as you would do in England. Remember that the sun may be North or South at midday, depending on the time of year and your position relative to the equator. However, the sun always rises in the East and sets in the West. At night the Southern Cross gives a good indication of South.

52. For crossing streams and rivers make a raft of bamboo or some other light wood. Palm logs and jungle hard-woods do not float. If anyone has to swim across a river, throw stones in the stream and splash about to scare off crocodiles.

53. Take things easily, giving yourself a break every hour or thereabouts, depending on the type of country. This break of five or ten minutes should be utilized to discuss your route, take refreshment, to de-leech and to repair clothing and equipment. Make an early start and strike camp early so that by sundown the camp is organized and all are ready to settle for the night.



LOG RAFT

54. Take all normal precautions to keep yourself fit and see that other members of the party do the same. Scratches and bites should be attended to right away, and make sure that due care and attention is given to the feet. This involves taking off all footwear at night and, where possible, washing and drying socks and stockings. Check footwear in the morning for scorpions by tapping them on the ground. If you find you are getting blisters on your feet, stop at once and put a dressing over the blister. Do not wait until the blister becomes unbearable.

55. The requirements of an ideal camp site are as follows :—

(*a*) Proximity to water and food.

(*b*) Solid ground tree from mud.

(*c*) Freedom from dead and decaying vegetation and insects.

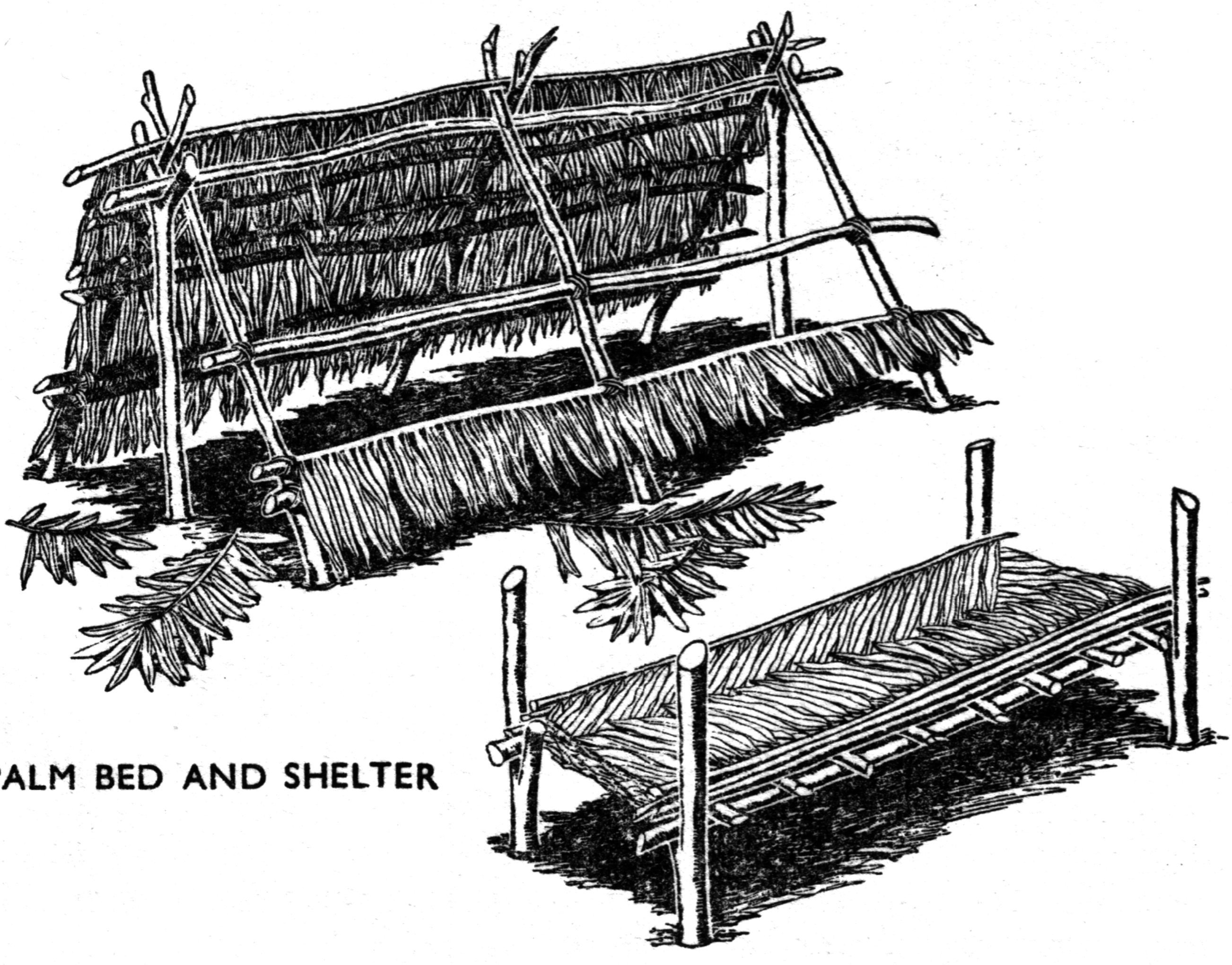
(*d*) Freedom from overhanging branches, or from coconuts overhead.

(*e*) Natural protection from weather and animal life.

(*f*) Concealment in wartime.

56. Unless one is able to keep dry and free from insects and other irritants, there will be little rest during nights spent in the jungle : so take some care over the selection of the camp site. Make your decision in good time so that the site may be made safe and comfortable before nightfall. Do not, however, insist on finding a place which meets all the above requirements or you are likely to search all night.

57. Start off by clearing away all dead and rotting vegetation, as such rubbish encourages ticks, ants, leeches, etc., and as soon as possible light a fire, as the smoke will drive away those irritating insects, quite apart from being ready to cook and heat water later on, as required. Arrange for a supply of bamboo, if it is available, as it will be found invaluable for cooking and boiling water.



PALM BED AND SHELTER

CAMPING SITE

58. Make yourself a bed, either by utilizing the parachute canopy you have brought with you or by collecting twigs and small branches from the trees, covering a cleared area of ground with them, and then adding a further covering of leaves. This will ensure your having a good night's rest, and also insulation against ground chill and dampness. You are likely to be very cold at night, so don't discard blankets and heavy clothes if you have them with you.

59. Your fire will produce a certain amount of ash, which should be removed from the fire, and spread in an unbroken line around the camp site, thus ensuring no intrusion from the innumerable insects to be found crawling around on the floor of the jungle.

DON'T camp in river beds, though they might look clear and dry, as a storm in the hills might flood the river in a few hours.

DON'T be too concerned about the proximity of water. If making camp for an indefinite period, consider the laying-on of a water supply by using sections of split bamboo in the form of guttering, having tapped the stream at a point further up from the camp site.

DON'T overlook the necessity of making sanitary arrangements, as this will avoid risk of developing one of the numerous diseases affecting the intestines. See that all refuse is deposited well clear of the camp, and buried if possible. (See First Aid and Personal Hygiene.)

FIRES

60. On the assumption that you have the means to kindle a fire, the following points should be borne in mind :—

(*a*) Use judgment in the selection of a fire site. Pick a spot where there is no danger of the fire spreading ; dry and sheltered if possible. During the wet season find a dry spot under a leaning tree or similar shelter.

(*b*) Use dry fuel, which may consist of dry grasses or plant stems, dry leaves or bark from trees. Dead wood from trees, and pieces found in rotting trunks or fallen branches will be found to be dry even in the wet season. Do not use wet bamboo as it may explode in the fire and throw out dangerous splinters.

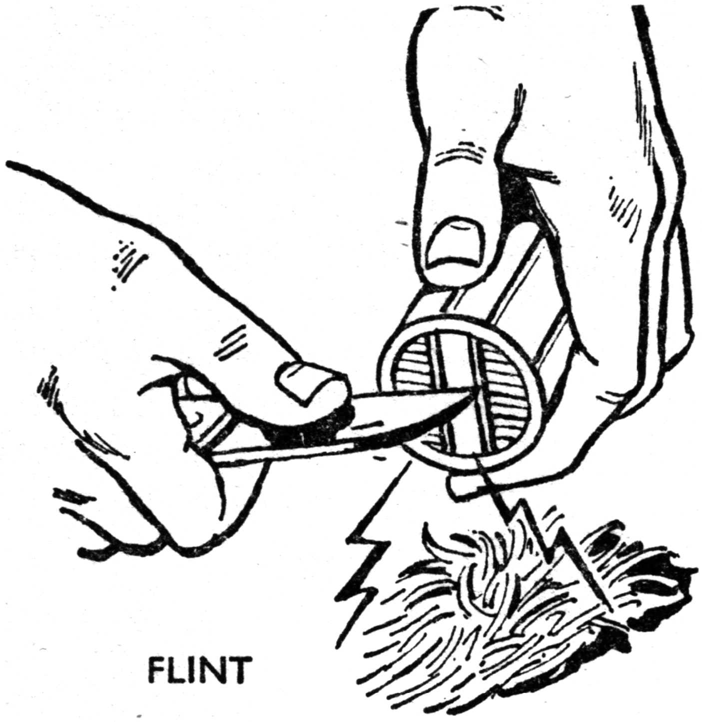
(*c*) Have a good supply of firewood and kindling available before starting a fire, and having got some of the smaller pieces of wood to burn, add the others and build the fire up, rather than attempt to start with a large one.

61. A fire, quite apart from giving a little moral comfort, discourages the approach of any wild animal, and also smokes away all forms of insect life. Remember when leaving camp to ensure that the fire has been properly extinguished, either by watering thoroughly, or spreading the ashes and stamping them out. In

dry country, prone to forest fires, use both methods and travel on with a clear conscience.

Methods of Kindling

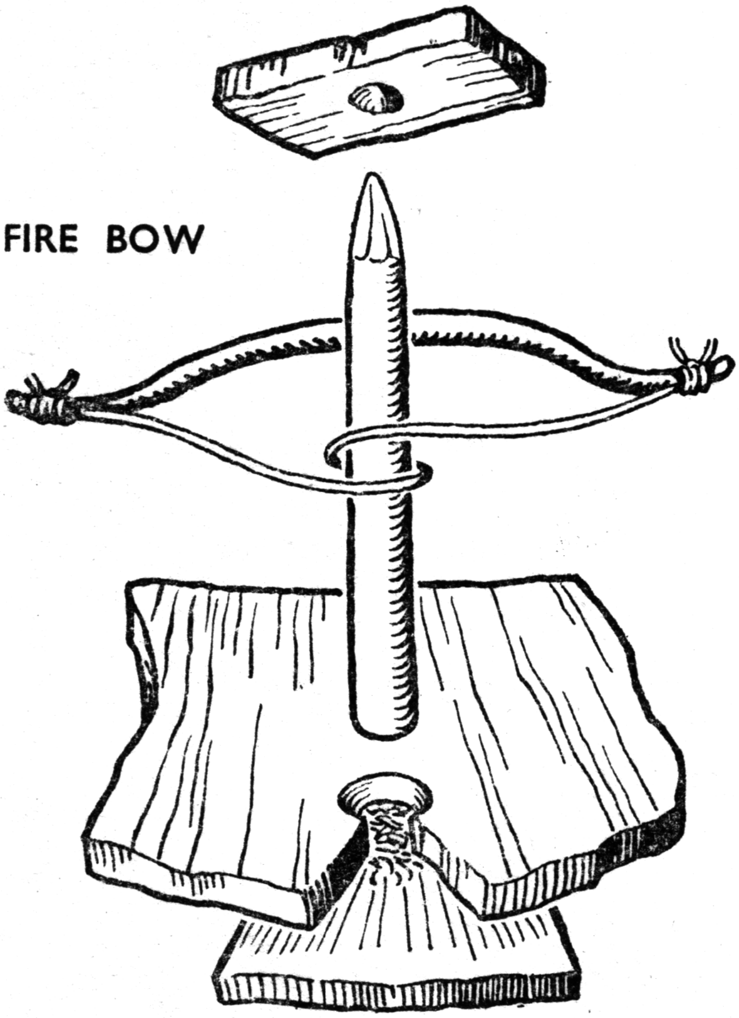
62. Although one reads of various methods of kindling a fire, apart from using matches, most of these will be found rather unsatisfactory. Rubbing pieces of wood together, or producing a spark from two stones or flints is all very well, but in practice it will not produce results in the hands of the inexperienced. It is, however, most essential for the "jungle hiker" to conserve his waterproof matches, as, rather obviously, these are going to be the easiest means of producing fire.



FLINT

63. Another satisfactory way is by using a piece of magnifying glass, or lens; often termed a "sun-glass". Aircrew flying over desolate tropical country should always see that they have one amongst the various "odds and ends" they choose to carry with them.

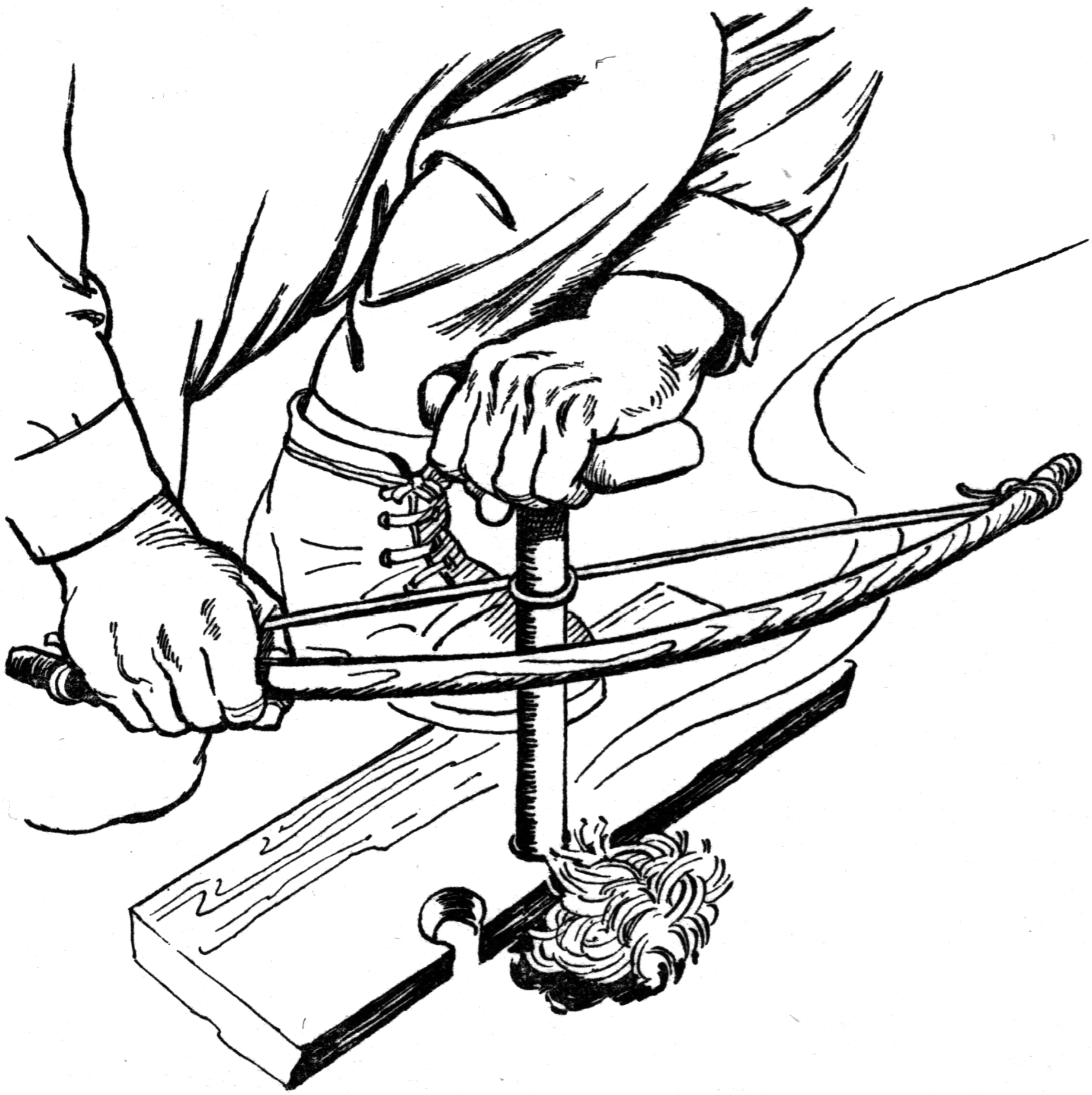
FIRE BOW



64. If faced with the necessity of producing flame without matches first of all see that you have everything ready to start a fire, such as plenty of dry small wood and kindling, and choose a suitable spot. Then go in search of a piece of straight dry wood, well seasoned; such wood might be found amongst dead trees;

pick a soft wood in preference to a hard wood, and use one of the following methods :—

(*a*) ***Fire, with Bow and Drill*** (***see illustration***). **Draw the bow backwards and forwards, causing the drill to spin in its hole, the action should be slow full strokes at the beginning, and working up to a fast stroke as the smoke begins to rise. Once smoke has been seen to come from the hole in the block a spark should be found large enough to start a fire. Take the block, and add a little tinder, blowing gently—you should then get a flame ; but be sure to build up the fire from a small start, otherwise it will most likely be smothered, and go out, when the whole procedure will have to be done again.**



BOW AND DRILL METHOD OF MAKING FIRE

(*b*) ***Fire Thong.*** Obtain a length of dry rattan, and draw it smartly across a soft dry piece of wood. Have the kindling underneath, ready to catch the embers as they drop.

(*c*) ***The Fire-Saw.*** This is another simple method, but requiring rather more physical strength and stamina than the other methods. It is just a question of drawing one piece of wood across another. A piece of split bamboo or soft wood will serve as one piece, using a sawing motion across another section of wood.

RUBBING TWO PIECES OF WOOD TOGETHER

<u>Note</u>: in 80% humidity jungle, dead wood is 16% water and will <u>NOT</u> burn.

Methods of Cooking

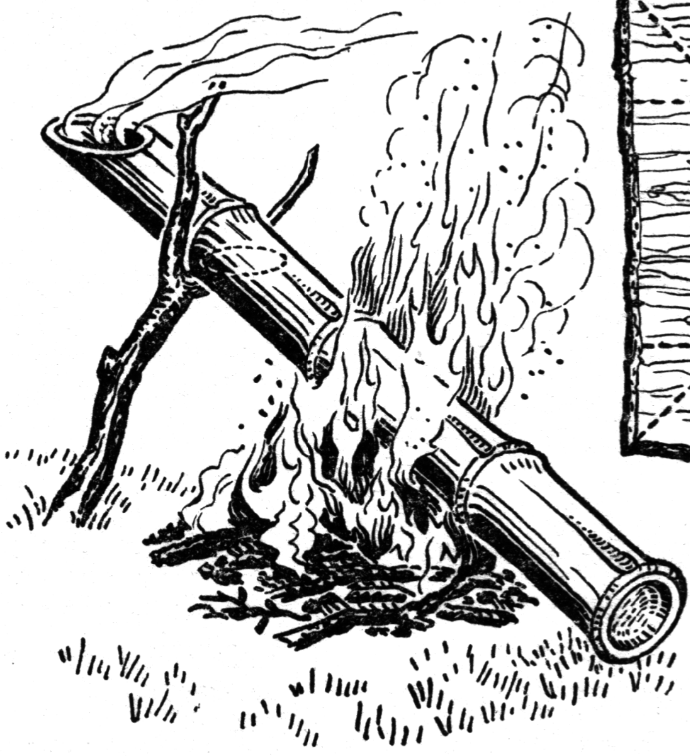
65. Food is generally more palatable and safer to eat when cooked than when eaten in its raw state, and there is no reason why anyone stranded in tropical country shouldn't have a hot cooked meal. Probably the most simple method is by "broiling" over a fire; all that is required is the fire and some means of supporting the food. This method can be used to great advantage with fish, and small joints, or animals.

66. Yams, potatoes, and some other roots can be placed immediately in the fire, and left until they feel tender. Clean, and remove the skin, and the meal is ready for serving.

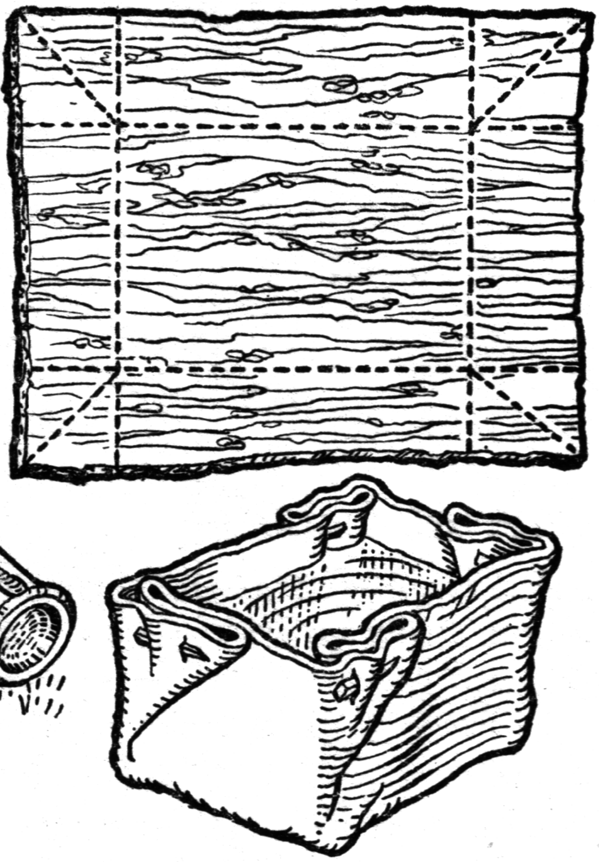
67. The gipsy method of cooking certain types of meat is another simple, yet very effective, method. This involves the collection of mud, or clay ; the food to be cooked is covered with it and placed in the fire. When ready remove from the fire and when the clay is broken open, the food will be found clean, and ready to eat. In the case of the porcupine, this method also removes all his quills with the greatest of ease.

68. Boiling food is always a good stand-by, and it is generally a question of finding a container in which to boil the water. This should not cause any difficulty, particularly if in the vicinity of a jungle stream or river, as a selection of bamboo will, no doubt, be found along its banks. There are two simple methods of boiling with the aid of bamboo, which incidentally will last for only two or three meals, before the wood becomes charred and leaks. If a considerable quantity of water is required, take a length of bamboo, perforate each water-tight section, except the bottom one, suspend over the fire, using a forked stick, in the manner of the illustration.

69. If only a small quantity of water is required to boil some fruits or vegetables, etc., take one section of bamboo, cut a hole in the top, and suspend over the fire by means of two horizontal sticks, or two pieces of jungle vine or rattan.



BOILING WATER



70. If bamboo is not available make a vessel from fibrous barks or leaves. A container thus made will not burn below the water-line ; moisten the area above the water-line to reduce the risk of the

container burning from the top. Keep the fire small, and the flames low, and there should be little difficulty in producing the required results.

Suggested Methods of Cooking various Types of Wild Food

71. *Fruits.* Boil succulent fruits, and bake or roast the thick-skinned and tougher variety.

72. *Potherbs (vegetables).* These are best boiled. In some cases, it may be necessary to boil in two or three changes of water in order to remove undesirable acids, etc.

73. *Roots.* Either bake, roast, or boil ; the former is probably the easiest of the three methods in this case.

74. *Small Game.* These may be cooked whole or in part ; if uncertain as to the quality of the meat, boil first, then roast or broil.

75. *Fish.* All methods of cooking are suitable for fish meat, and remember that most of the fresh water fishes should be boiled, before eating or cooking by any other method.

76. *Reptiles.* The smaller varieties can be toasted over a fire, but such things as snakes, eels, and turtles are best boiled. In the case of the latter, when cooked the shell will come away from the meat ; it makes a good meal if boiled in vegetables, with the meat cut up. Serve as a stew or soup.

77. *Crustaceans.* The simplest method of cooking these is by boiling. They require little cooking, but will spoil very quickly after being caught.

SALT

78. This is required in cooking, and to ensure the proper functioning of the human body. It can be obtained from sea water, also the ashes of burned nipa palm boughs, hickory, and one or two other plants contain salt that can be dissolved out in water. The salt remaining after evaporation is a dark gritty substance. The salt tablets from the Tropical First Aid outfit can be used for cooking.

WATER

79. Survival is more dependent on a supply of drinking water than on any other factor. Your emergency rations are no good to you unless you have the drinking water to go with them. Remember that with water alone one can expect to survive for about three weeks, but without water the average man will last no longer than two to five days.

80. In tropical forest, the availability of water is not so great a problem as its purity, and the table given later in this section shows where water can be obtained, and which of the sources should be purified before drinking. All non-flowing water found on the surface should be purified, and there are a number of alternative methods of doing this, as shown :—

(*a*) Use the halazone tablets in the Survival Kits, and allow to stand for 10-15 minutes.

(*b*) Use two or three drops of iodine to one quart of water, and allow to stand for 30 minutes.

(*c*) A few grains of permanganate of potash to one quart of water, and allow to stand for 30 minutes.

(*d*) Make a container from bamboo, if nothing else is available and boil for at least three minutes.

RAIN TRAP

81. Numerous jungle plants have natural receptacles in which water will be found ; though in certain cases, such as the cups of the pitcher plants, the water will be foul with decaying insects and quite impossible to drink. One of your most plentiful sources of water is in the jungle vines, or the rattans, which hang suspended amongst the trees and jungle vegetation. By cutting a length of about four feet, from the lower portion of the vine, the jungle

hiker will obtain a quantity of cool refreshing water, in no need of purification. A word of warning, however; look out for those vines giving a milky or dark-coloured sap, as they should be avoided.

82. When drinking from a jungle stream, if you consider the water pure and fit for drinking, don't drink direct from the surface, but cup your hands, or use a drinking mug of some sort, so that you can see what you are drinking, and avoid swallowing such things as leeches, or other small water life. If you find a plentiful water supply, drink as much as you can, as the body can store plenty of water for future use.

83. At times, it is often found necessary to use for cooking and drinking, water obtained from animal watering places, or large rivers, the water being muddy, and cloudy. This is not necessarily dangerous, and this water can be purified by one of the methods mentioned above. It is better to filter this water, and endeavour to clear it; this can be done by allowing it to stand for a while, overnight perhaps, with a cover on the container. Then, to filter, use a sand-filled cloth, or a bamboo stem, filled with leaves or grass.

84. ***Sources of Water in Tropical Forests.*** Fresh water, not in need of purification :—

- (*a*) ***Rain.*** Build a rain trap from large leaves, with framework made up from bamboo or branches.
- (*b*) ***Jungle Vines (and Rattans).*** Select the lower loop of any vine, and cut out a length of four or five feet, from which drinkable water may be drained.
- (*c*) ***Streams.*** All fast flowing streams, having a mixed sandy and stone bed, provide clean water. If there is no sign of animal deposits, or sewage within half-a-mile up stream, this water will also be pure, and ready for drinking.
- (*d*) ***Plants.*** During the monsoon or rainy season water can be collected from natural receptacles found on various plants. This will be fresh rain water, and fit for human consumption.
- (*e*) ***Bamboo.*** In the base of large bamboo stems will be found drinking water. It is not possible to guarantee finding water from this source on every occasion.
- (*f*) ***Coconuts.*** In the green unripe coconut will be found a very good substitute for fresh water, *i.e.* "coconut milk". One nut may contain as much as two pints of this delicious cold fluid. Do not drink the "milk" from the ripe, or fallen coconuts.

85. ***Sources of Water which should be Purified before Drinking***

(*a*) ***Water Holes.*** Water found here will probably be muddy, and with pieces of rotten vegetation in it, so filter it first, then allow to stand for a few hours, filter again, then purify by one of the methods suggested at para. 80.

(*b*) ***Digging.*** Treat water as for (*a*) above. If on the sea-shore, dig a small hole a few yards above high tide, and as soon as you find water collecting, stop digging. Water collected in this way should be fairly free from salt, the fresh water floating on the top of salt water, hence don't go too deep. The water obtained in this way may taste slightly brackish, but will be safe to drink. If very strong, filter it a few times, or try again further up the fore-shore.

(*c*) ***Stagnant Water.*** This is not necessarily infected, but in order to make sure, filter it, then purify. Stagnant water may be found in small pools, amongst rocks, dead tree-stumps, etc.

(*d*) ***Large Rivers.*** This water will be muddy and probably infected, so treat as for water holes.

SOLID FOOD

86. Plant food alone is not likely to keep you alive indefinitely unless you are prepared to spend all day hunting for it. It will, however, prove a welcome addition to other food and will keep starvation away for several days. There are a number of potential food plants to be found throughout the jungle, but the most common, found in abundance in the tropics, are mentioned here. These are selected because of their abundance, simplicity of preparation for eating, and comparative ease with which they can be recognized.

87. In addition, it is to be strongly recommended to those stationed in tropical areas that they obtain the assistance of a native guide, and arrange for an instructional walk through a typical part of that country over which they operate, or visit the nearest botanical gardens.

88. There is no need to worry unduly about the effects of poisonous plants, for though a few might be considered highly dangerous, the greater number will most likely cause you to be indisposed for a matter of days. With reasonable care, and by taking the normal precautions when taking strange foods, your troubles should be small. Should you at any time be uncertain of the plant you wish to try, the following points may be of guidance :—

(*a*) Eat sparingly of any strange plant, until you can be quite certain as to the reaction, if any, it might have on you.

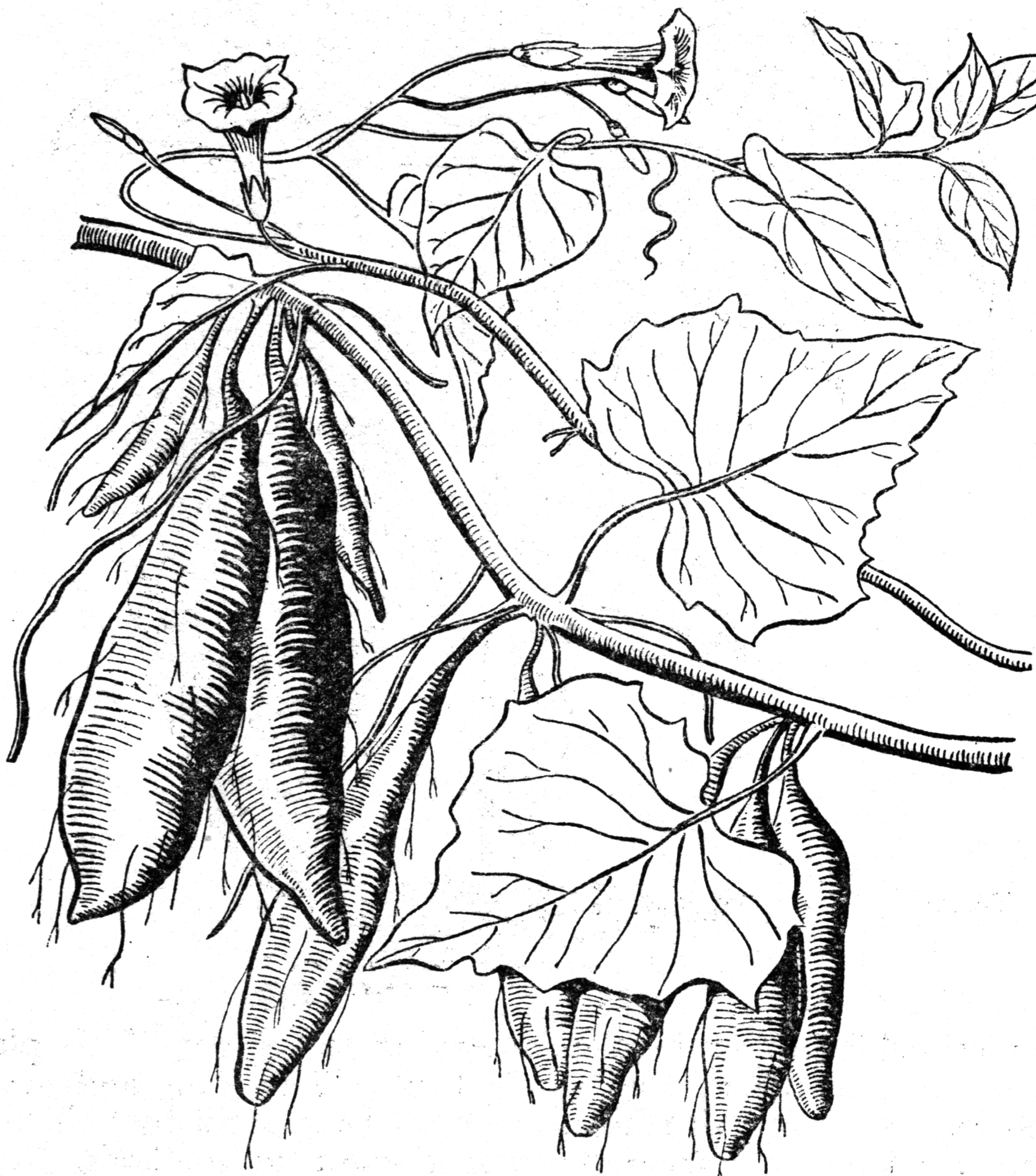
(b) Avoid all those things which are unpleasant to the taste, those which are bitter, or acid, etc.

(c) Avoid those plants, with one or two special exceptions, which give a milky or soapy sap.

(d) If in doubt, endeavour to see what the monkey thinks of the food, for you can always rely on him deciding whether plants are fit to eat.

Selected Foods

89. ***Sweet Potatoes.*** Have a vine-like growth, with leaves, and flowers that resemble those of the "morning glory". The potatoes



SWEET POTATO

may be eaten raw or cooked, the latter by placing in a ground oven, or in the base of a fire after which clean them, and peel. In addition to the potato, the young shoots and leaves are delicious when boiled, and make an excellent substitute for spinach.

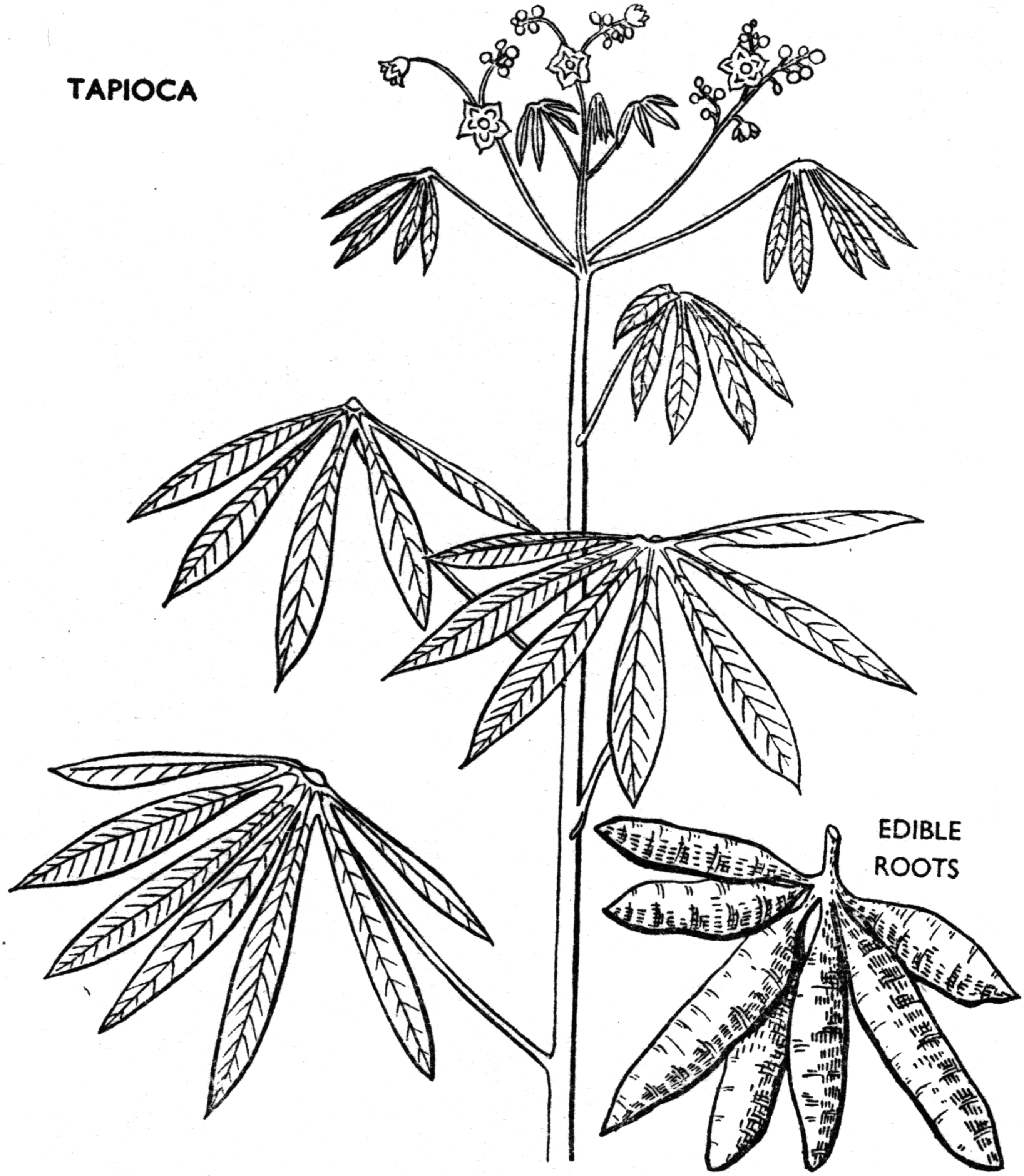
90. ***Taro.*** A plant two or three feet in length, with a large heart-shaped leaf, resembling "elephant ears". Taro has thick potato-

TARO

like roots which differ in size, according to variety. This plant provides one of the natives' staple foods. The roots and young leaves and stalks are all edible, but must be cooked, by boiling or roasting, which are generally the simplest of methods. After cooking, the roots may be peeled, then mashed into a doughy-like

mass, with the addition of a little water. This may be preserved, if required, for a few days, by wrapping in leaves.

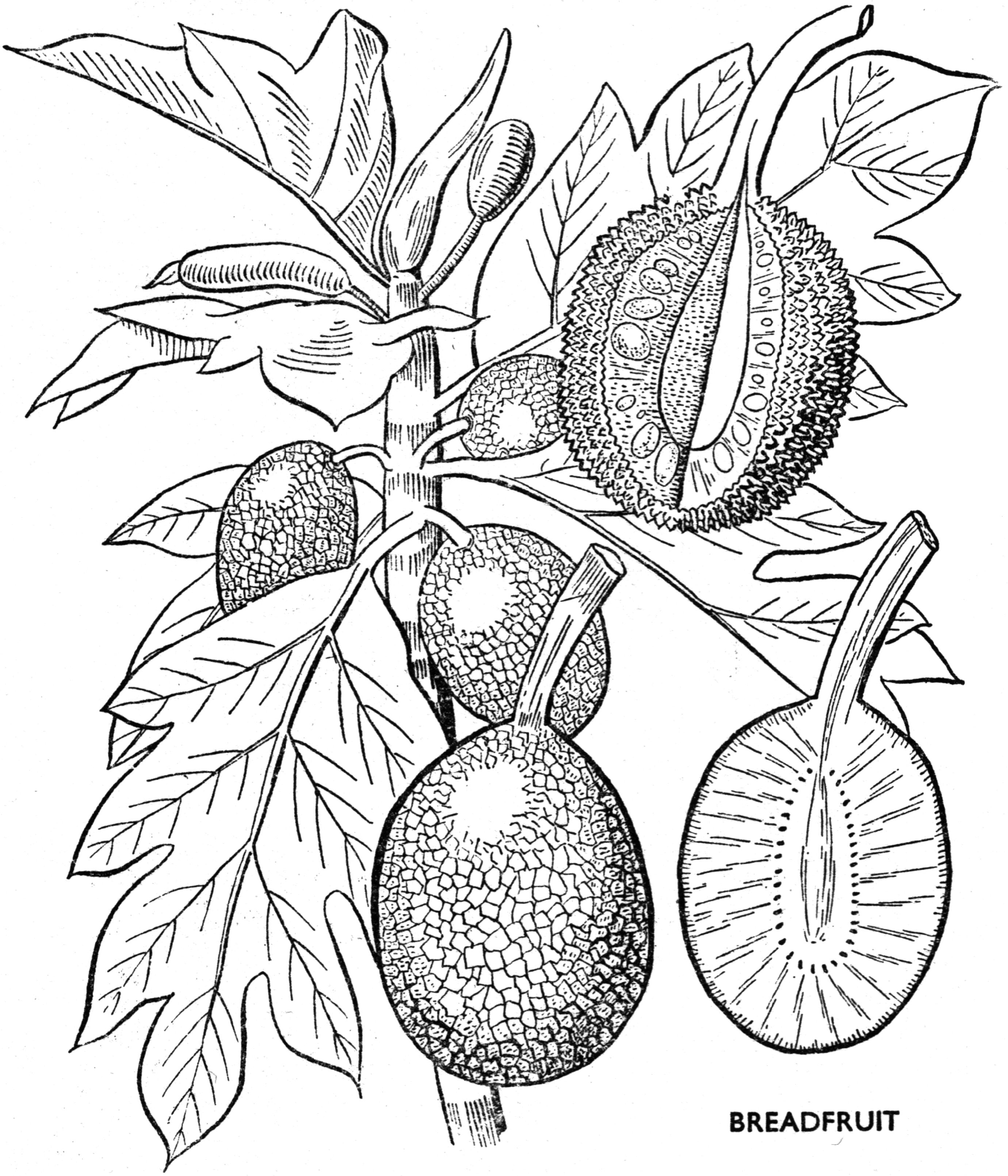
91. ***Tapioca.*** Known as cassava or manico. The plant is shrubby and three to seven feet high, with large tuberous roots, this being the edible portion, which vary in size from six inches to



as much as two feet. There are two basic types, the sweet type, and the bitter : and one can only be distinguished from the other by the taste. Avoid the bitter type, unless it can be cooked, as it is highly poisonous, containing the basis of the deadly hydrocyanic acid. To cook the bitter type, grate or mash the roots into

pulp, squeeze out the juice, and make the remaining "dough" into cakes, which can then be baked in the ordinary way.

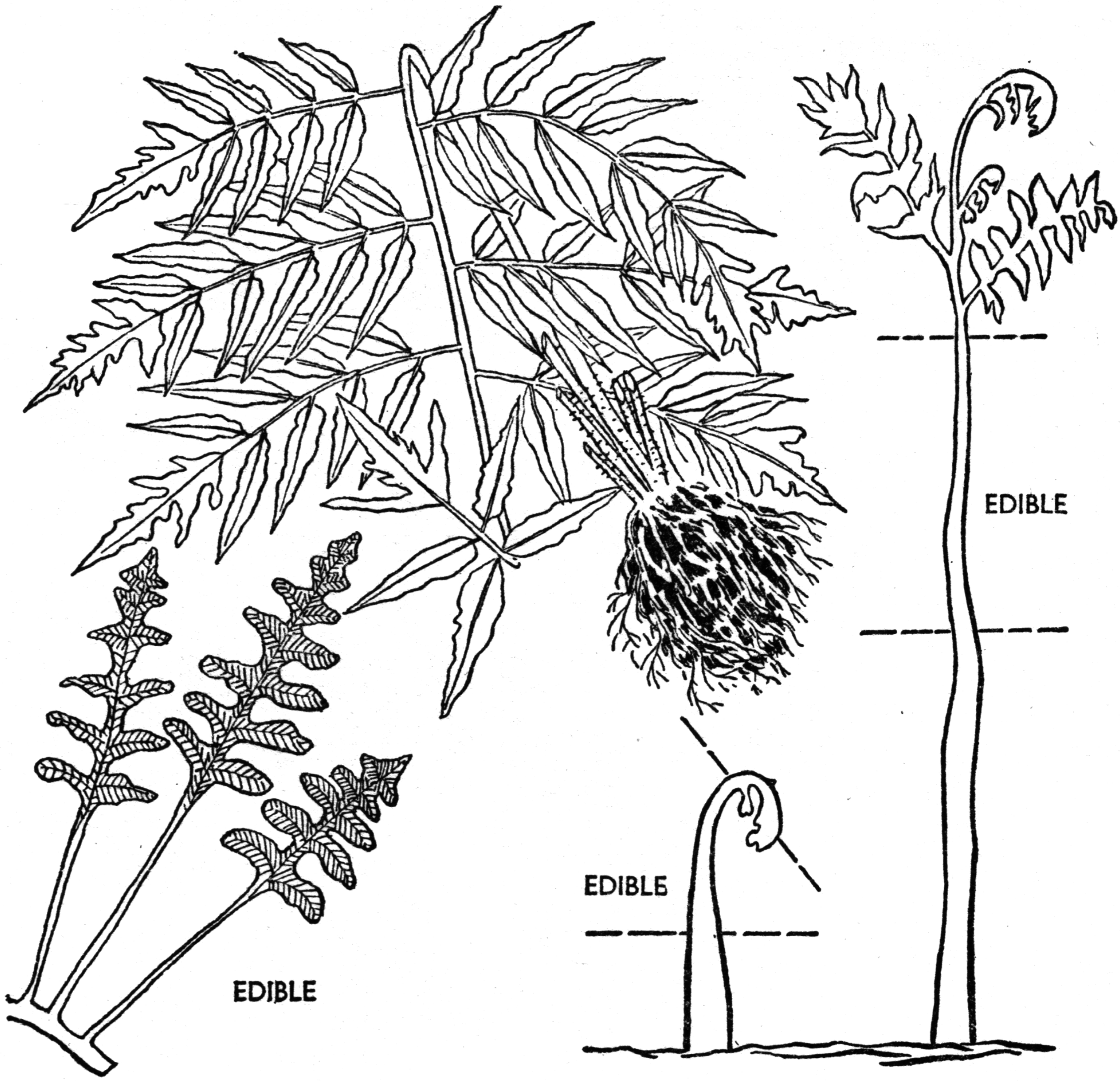
92. ***Breadfruit.*** Should always be cooked before eating. The most practical way is to bake the entire fruit in hot embers for



BREADFRUIT

half-an-hour or so, then peel off the skin before serving. It can also be boiled, baked, or cut into slices and fried. To preserve, boil first, then cut into strips, and allow to dry-out in the sun. When required these slices can be served without any further preparation. The seeds may also be eaten if boiled or roasted.

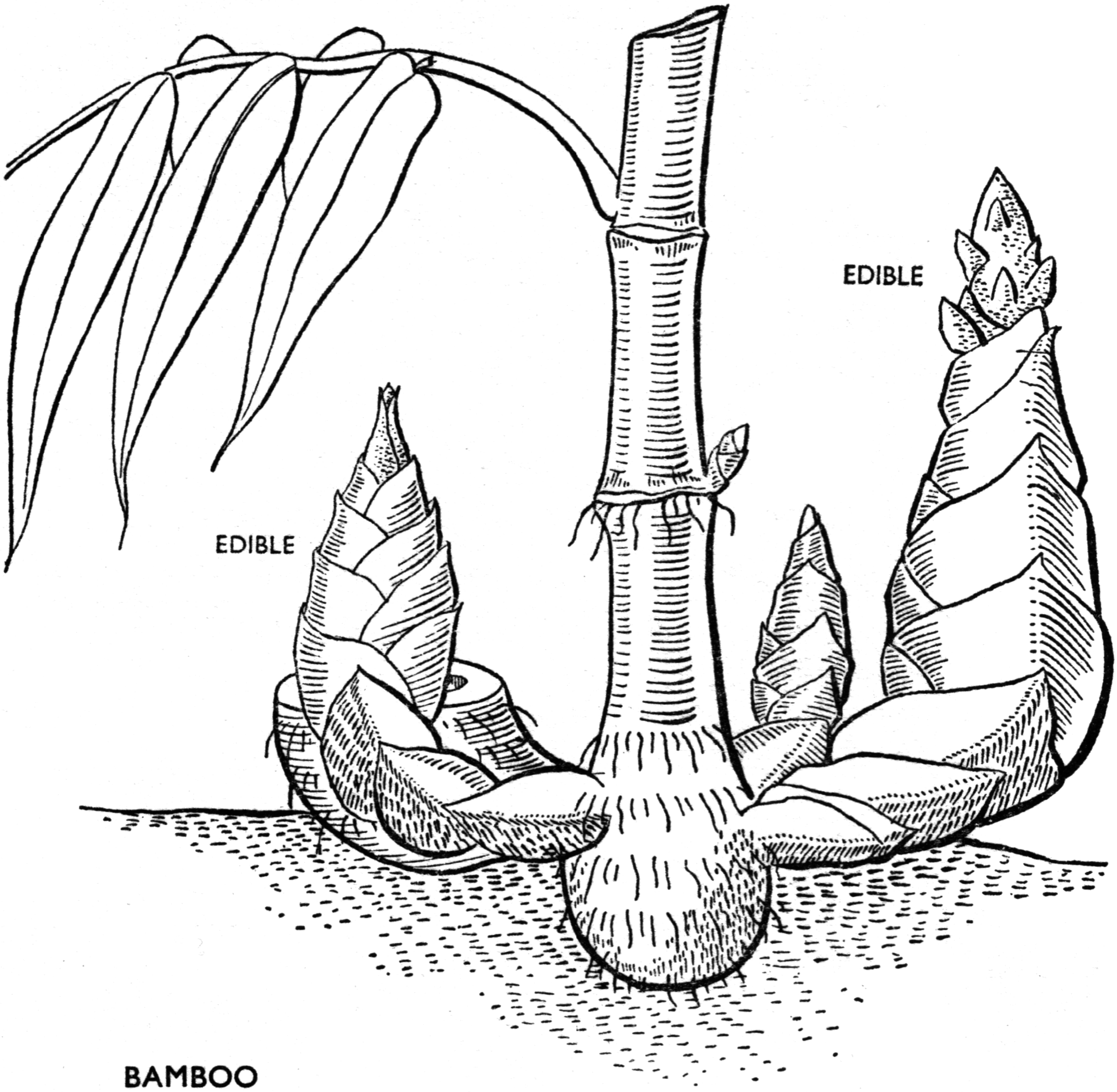
93. ***Ferns.*** Several varieties are abundant in many areas, and are to be found in marshes, swamps, along water courses, and



FERNS

other camp shady places. The tree ferns will be found throughout the forests. The tips and shoots of most of the ferns are good food, raw or cooked, and because of their widespread distribution, their accessibility, and ease of recognition, may well serve as a most important source of diet. Ferns, like all the food to be found in the jungle, should be taken in small quantities during the first few days, as the change in the form of diet may have an adverse effect on the stomach and intestines and cause diarrhoea. Though ferns are so readily available, they are not particularly nourishing, and if other forms of food can be found, it would be well to vary the diet.

94. ***Bamboo.*** Here is a good emergency food, which is familiar to everyone, and is widely distributed throughout all tropical



BAMBOO

climates. The young shoots, up to a foot or so in height, can be eaten raw, but are more palatable if cooked. See that the fine black hairs along the edges of the leaves of the small shoot are removed before cooking, as they are poisonous.

95. ***Coconuts.*** These contain, not only good drink, but also good food. First there is the meat inside the nut itself, which makes good eating, and also can be made to yield coconut oil, which is a useful preventative for sunburn. In addition there is the palm "cabbage". The cabbage is found in the top of the palm, inside

the sheath from which the leaves protrude, and may be eaten raw, boiled, or roasted. Where it tastes pleasant it makes an excellent vegetable though some varieties may be bitter. The coconut is an excellent food and palm trees are numerous, but getting the nuts is not quite so easy; healthy coconuts do not fall

COCONUTS

off trees, but have to be plucked by hand. If you can get a native to go up the tree, so much the better ; if not pick a small and sloping tree and climb up as best you can. When you have got

the coconut, the next problem is to open it. The husk may be cut away with a machete, but the best way is to place a stout

BREAKING COCONUTS

pointed stick in the ground point uppermost and bang down the coconut on the spike. When you have got a split in the husk, use the spike as a lever to prize it off; once the husk is removed it is easy to break open the inner shell.

96. ***Seaweeds.*** All forms of seaweed are edible; oddly enough they are not particularly salty in flavour, and their water content is fairly fresh. Seaweed is probably more palatable in its raw state, and the best types will be found amongst the pink and purple variety and the reddish or green types.

97. ***Water Lilies.*** Those types found on the surface of fresh-water lakes and in streams are a source of food. All these types

WATER LILIES

are edible, and the seeds and thickened roots of all varieties may be eaten boiled or roasted.

98. ***Fruits.*** It is amongst the infinite number of different fruits to be found in the tropics that the main troubles lie. There are quite a number of poisonous types, and it would be well to receive some local advice as to those types found in abundance, which are either edible or poisonous. Fruit found in native allotments is safe to eat.

Poisonous Plants

99. In order to avoid the poisonous plants to be found throughout the tropics, and in particular the Far East, the following rules should be observed and the list of poisonous plants identified and memorized :—

(*a*) Do not eat red—or brightly coloured—fruits and berries unless you know them to be harmless. Avoid anything looking like a tomato, though it might smell quite pleasant.

(*b*) Do not eat roots, fruits, and vegetables with a bitter, stinging, or otherwise disagreeable taste. If in doubt, taste with the tip of your tongue, or take a minute piece spitting it out immediately should you consider it to be amongst the poisonous variety.

(*c*) Avoid all contact with any plant, shrub, or tree, with a milky sap.

(*d*) On certain types of young bamboo there is a prickly form of down, which causes intense irritation and sores. When working this type of bamboo, be certain to wear your jungle gloves, or at least cover your hands.

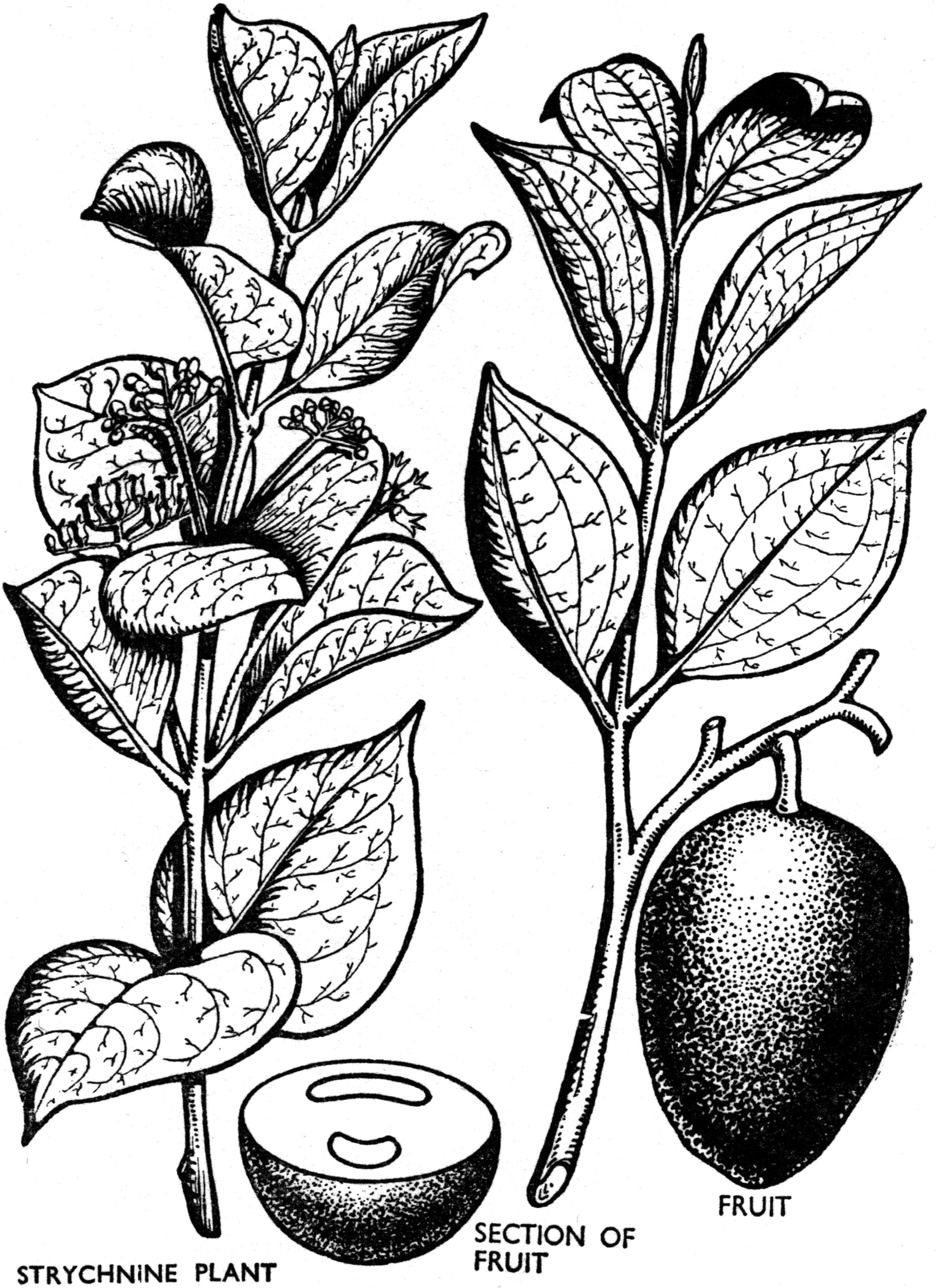
(*e*) Leave all toadstools or mushrooms alone.

(*f*) Because birds and animals eat certain types of plants, it is no guarantee that it will be safe for human consumption, as most animals can digest foods that are poisonous to man. In an emergency, if you can find nothing eatable, watch the food the monkey eats, as you can be certain that he is eating food fit for human consumption.

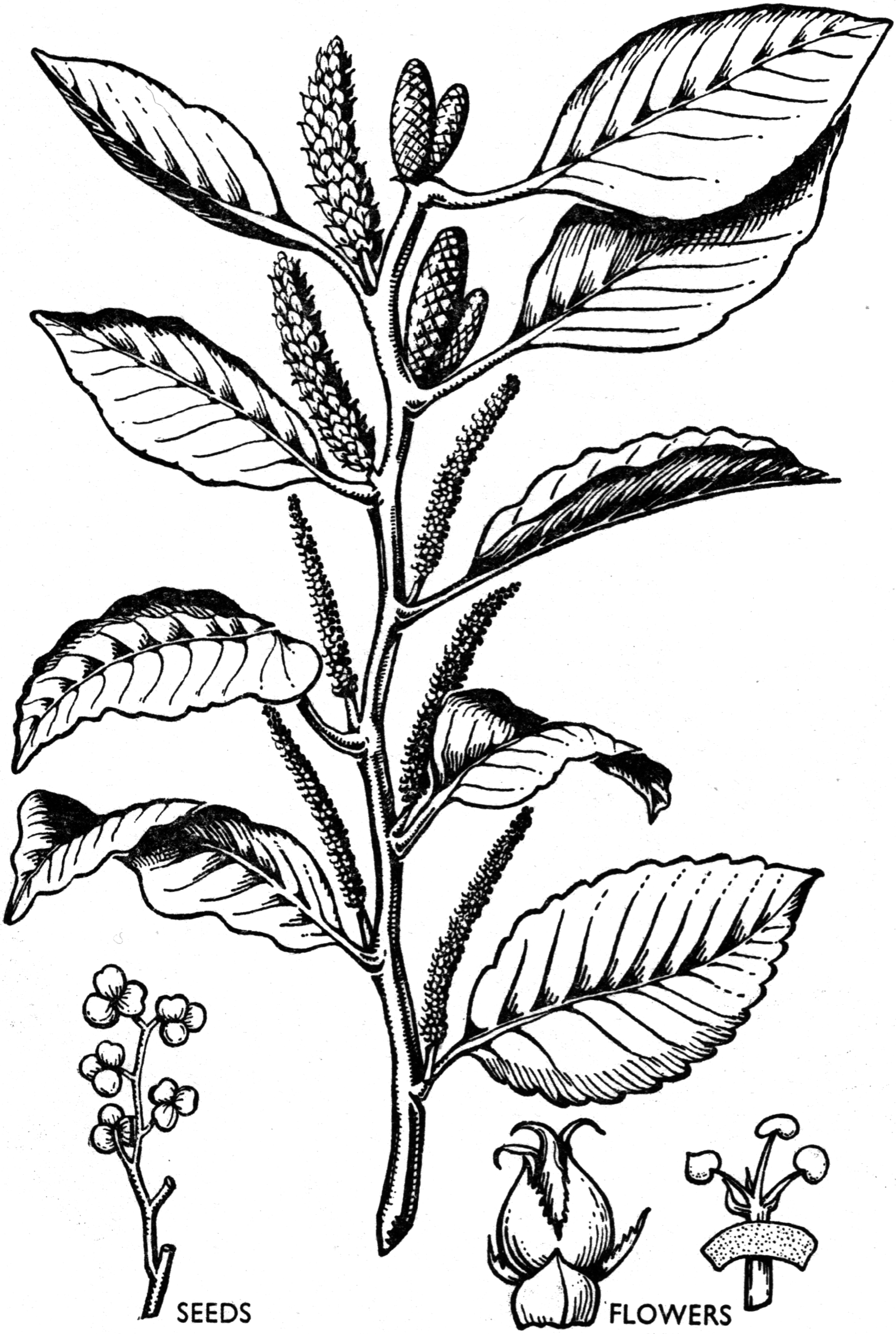
100. ***List of Poisonous Plants.*** A few of the most common and more dangerous of the poisonous plants are listed separately as follows:—

(a) ***Strychnine Plant.***

Grows wild throughout the tropics. Seeds contain deadly strychnine.



(*b*) ***Milky Mangrove, or Blind-your-eyes.***
Found in mangrove swamps, on coast or estuaries.
Sap causes blistering, blindness if in the eyes.



MILKY MANGROVE OR BLIND-YOUR-EYES

(*c*) ***Cowhage, or Cowitch.***

Found in thickets, and scrub. Not in true forest. Hairs on flowers, and pods, cause irritation and blindness if in the eyes.

COWHAGE OR COWITCH

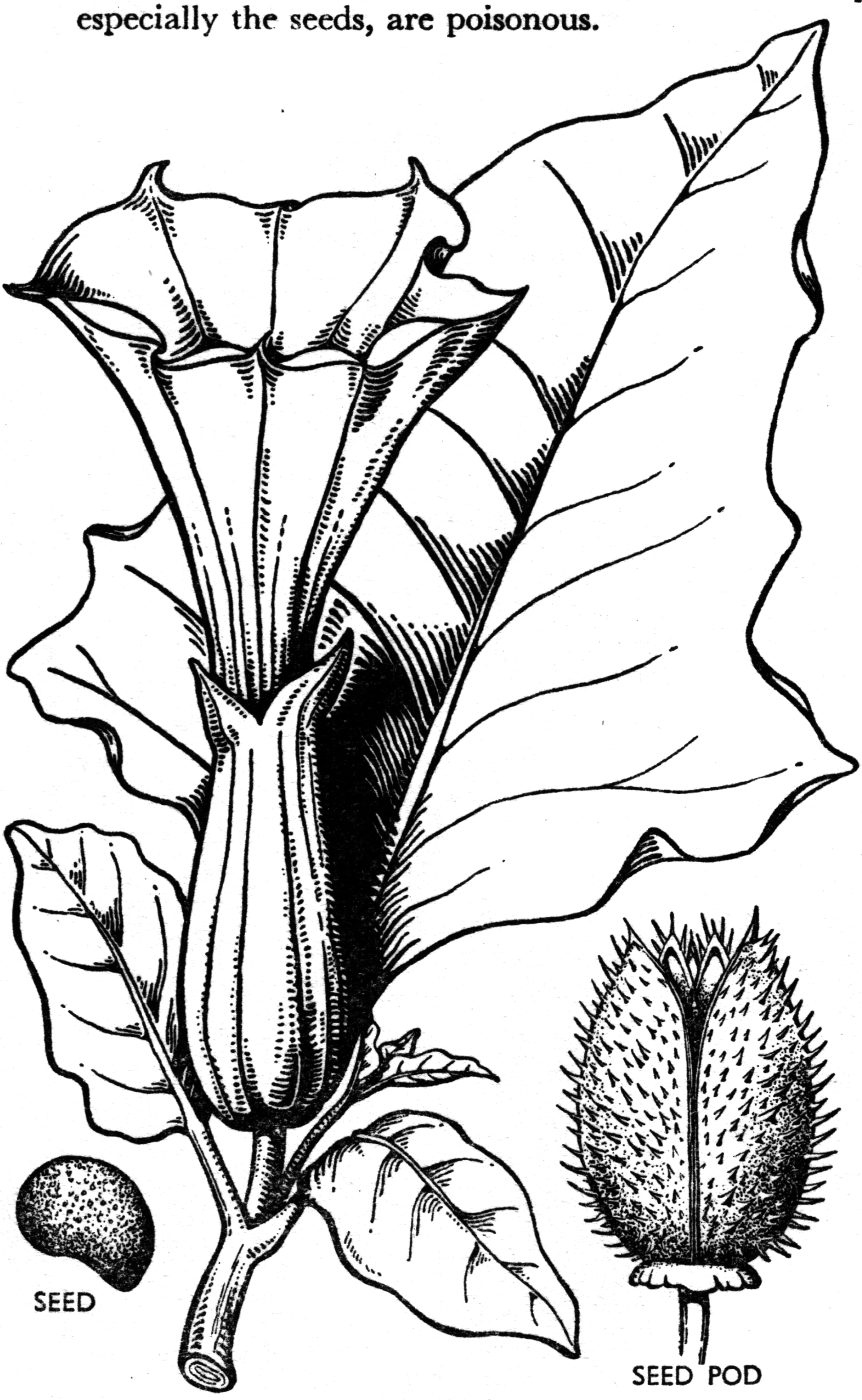
FRUITS

(d) ***Nettle Tree.***

Widespread, especially in and near ponds. Poisonous to touch, causing burning sensation. Relieve with wood ashes, moistened.

(*e*) ***Thorn Apple.***

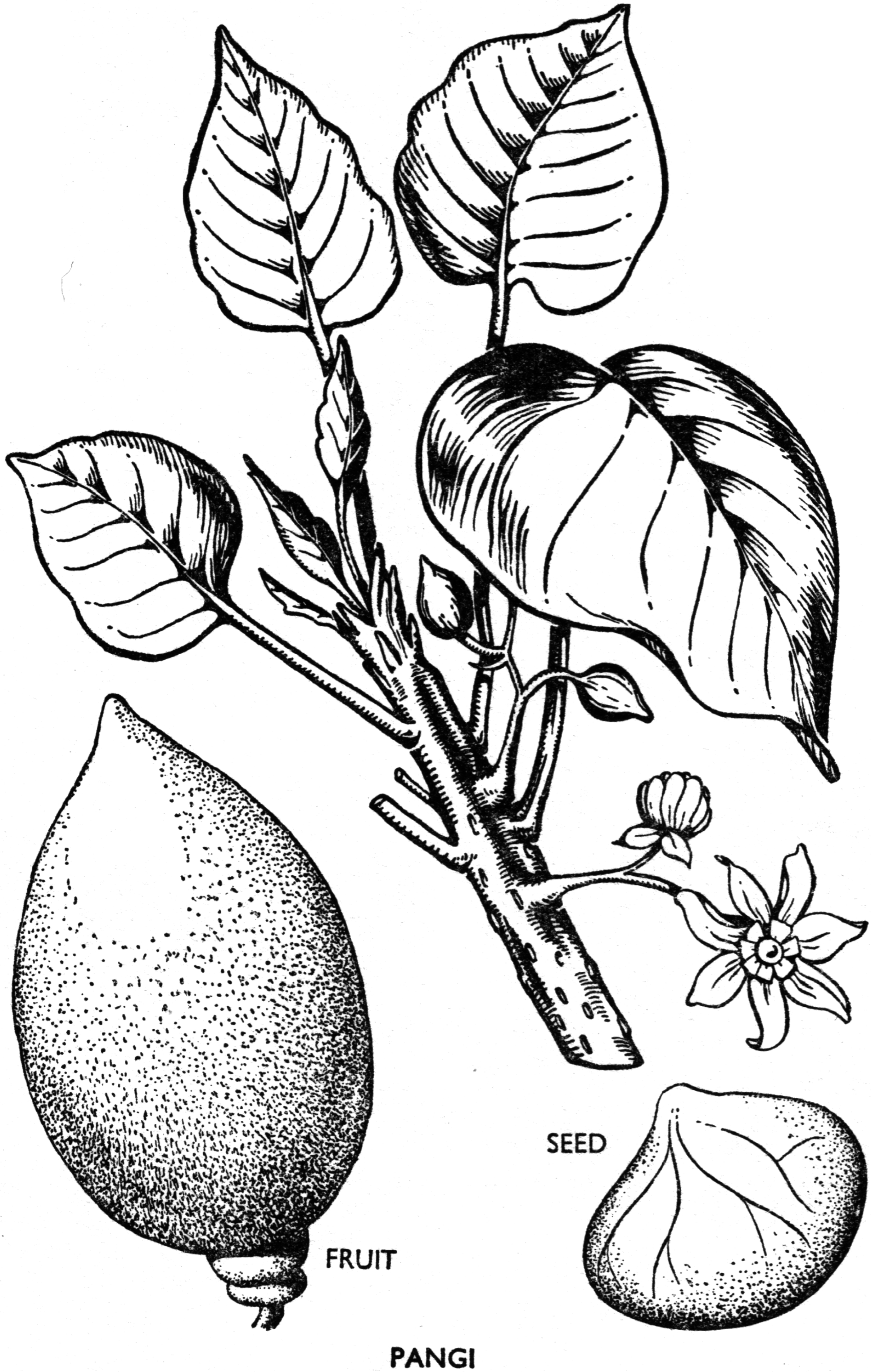
Common weed of waste and cultivated land. All parts, especially the seeds, are poisonous.



THORN APPLE

(*f*) ***Pangi.***

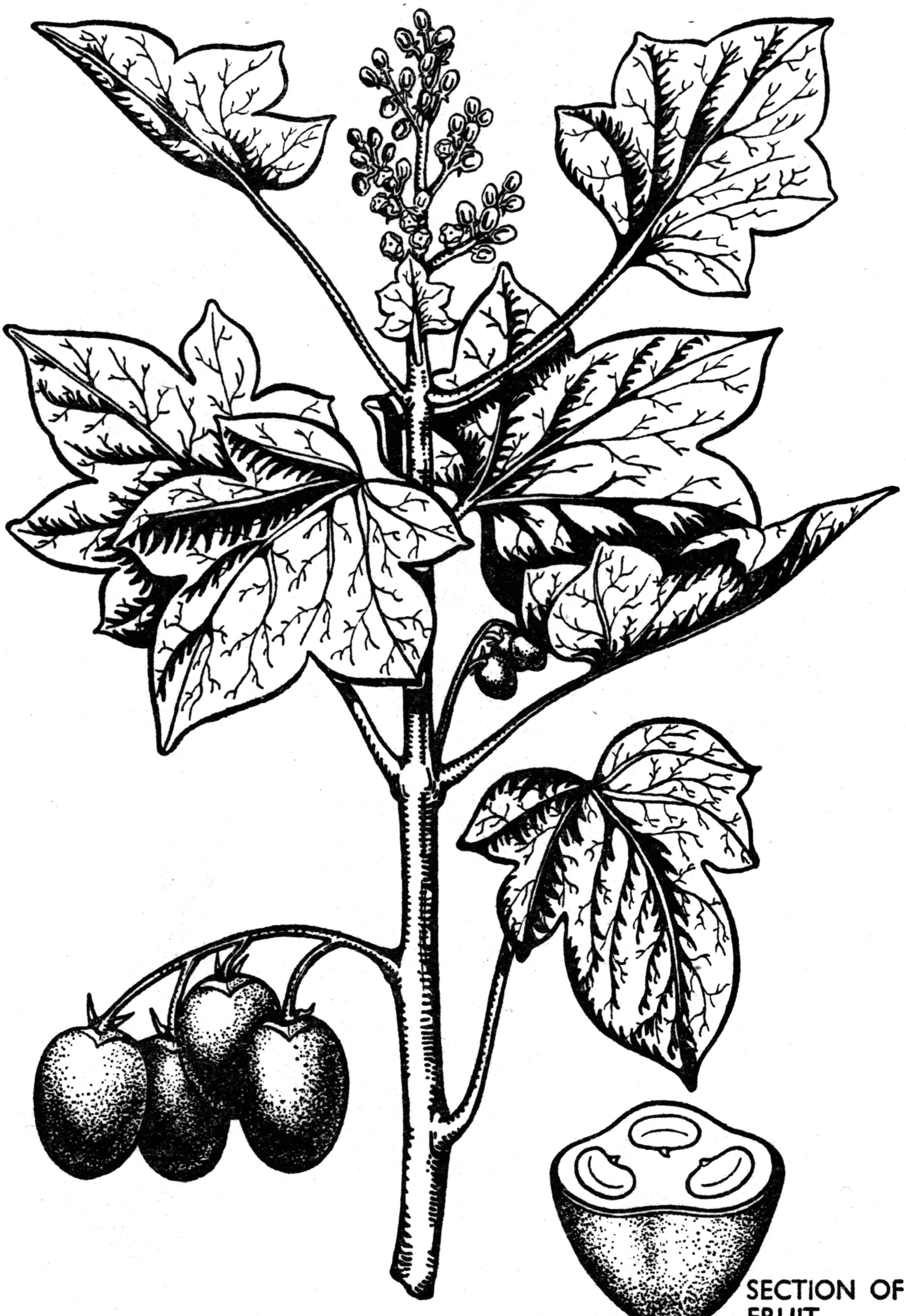
Found mainly in Malayan forests. Seeds of the large brown fruits contain prussic acid.



PANGI

(*g*) ***Physic Nut.***

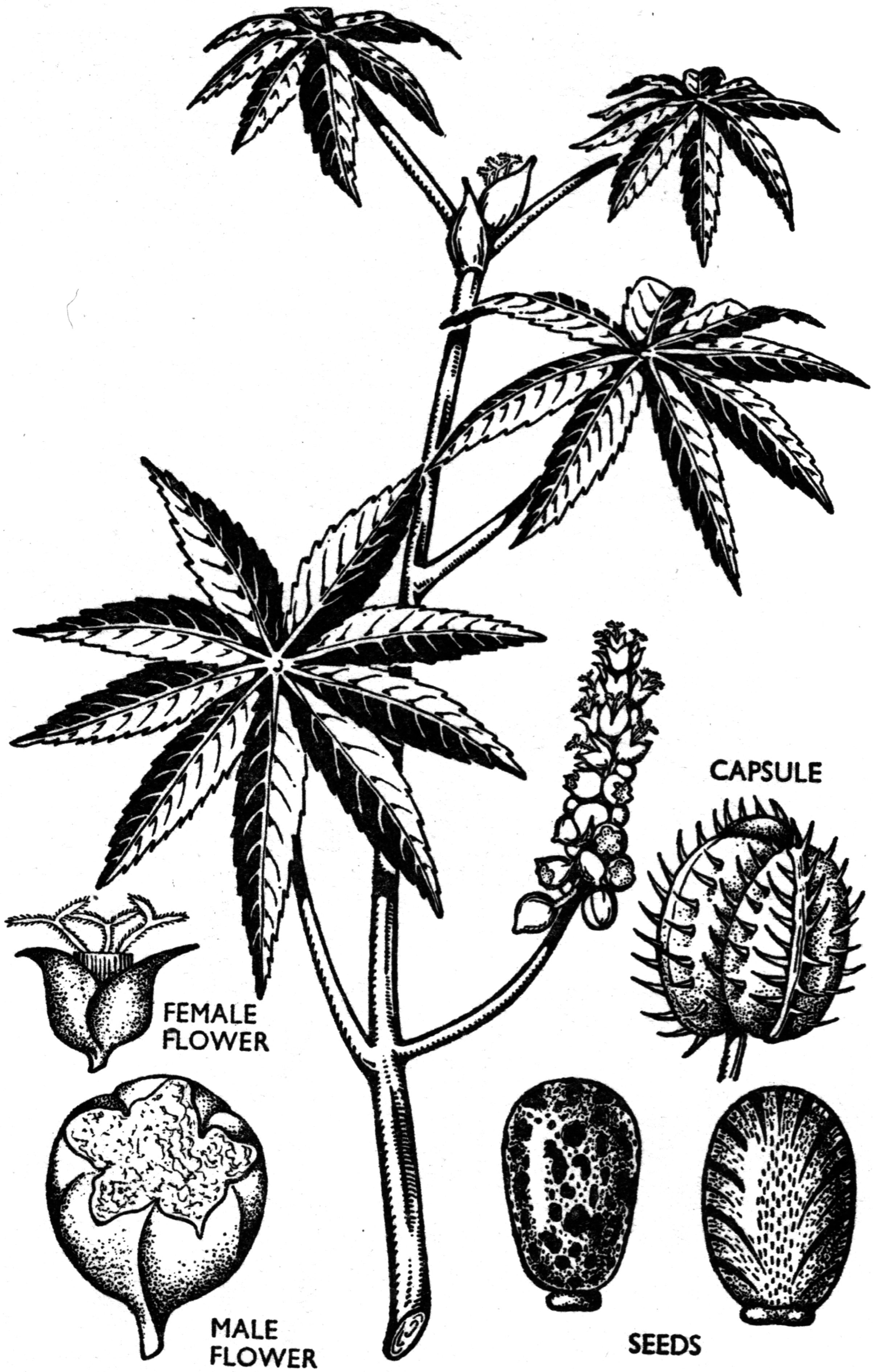
Common in fences, and hedgerows. Large seeds, violently purgative.



PHYSIC NUT

(*h*) ***Castor Oil Bean.***

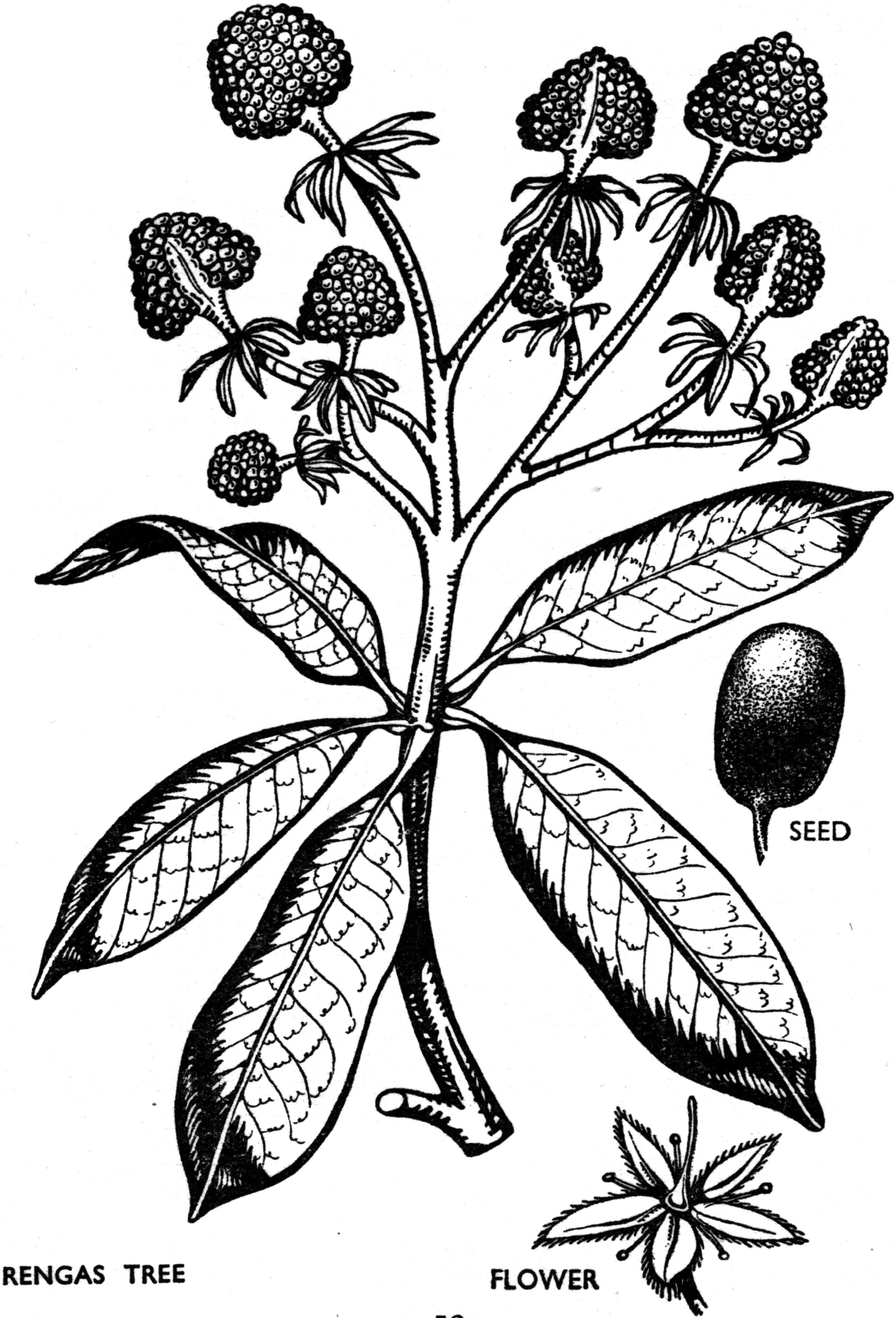
A shrub-like plant common in thickets and open sites. Seeds are poisonous, and a violent purgative.



CASTOR OIL BEAN

(*j*) ***Rengas Tree***

Widespread in Malayan forests. Localized rash caused from contact with bark, timber, or water off the tree.

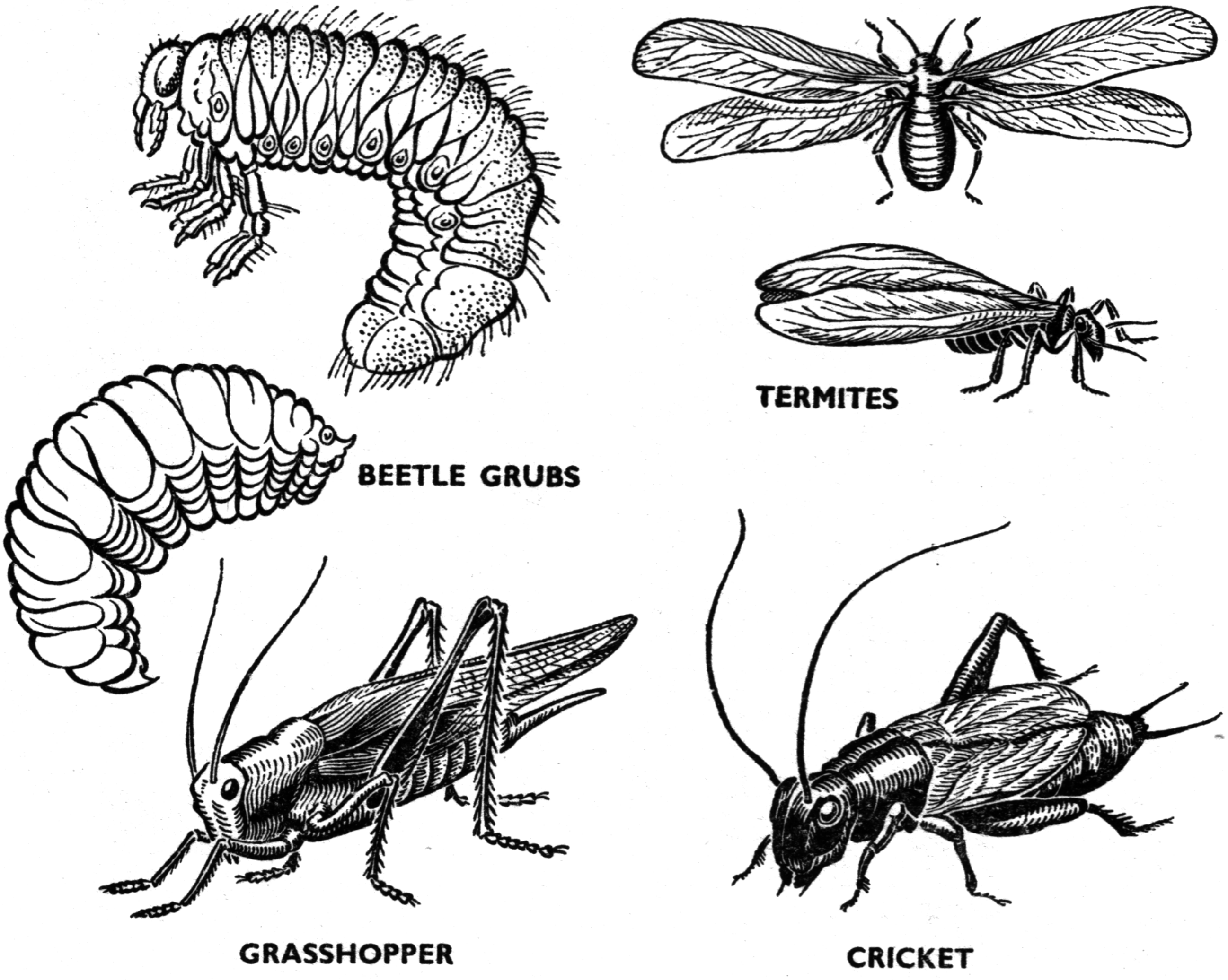


Meat, Birds and Insects

101. ***Birds.*** All birds are edible, though a few, including the carrion-eating vultures and kites, have a flesh which is most unpleasant to the taste.

102. ***Lizards and Snakes.*** All these are edible, the meat from the hind quarters and tail in the case of the lizard being the best. Snakes are not going to be so easy to catch, or to find for that matter, but if you do happen to contemplate a meal of snake, remove the head immediately the reptile has been killed. Frogs are quite good food but they should be skinned before cooking.

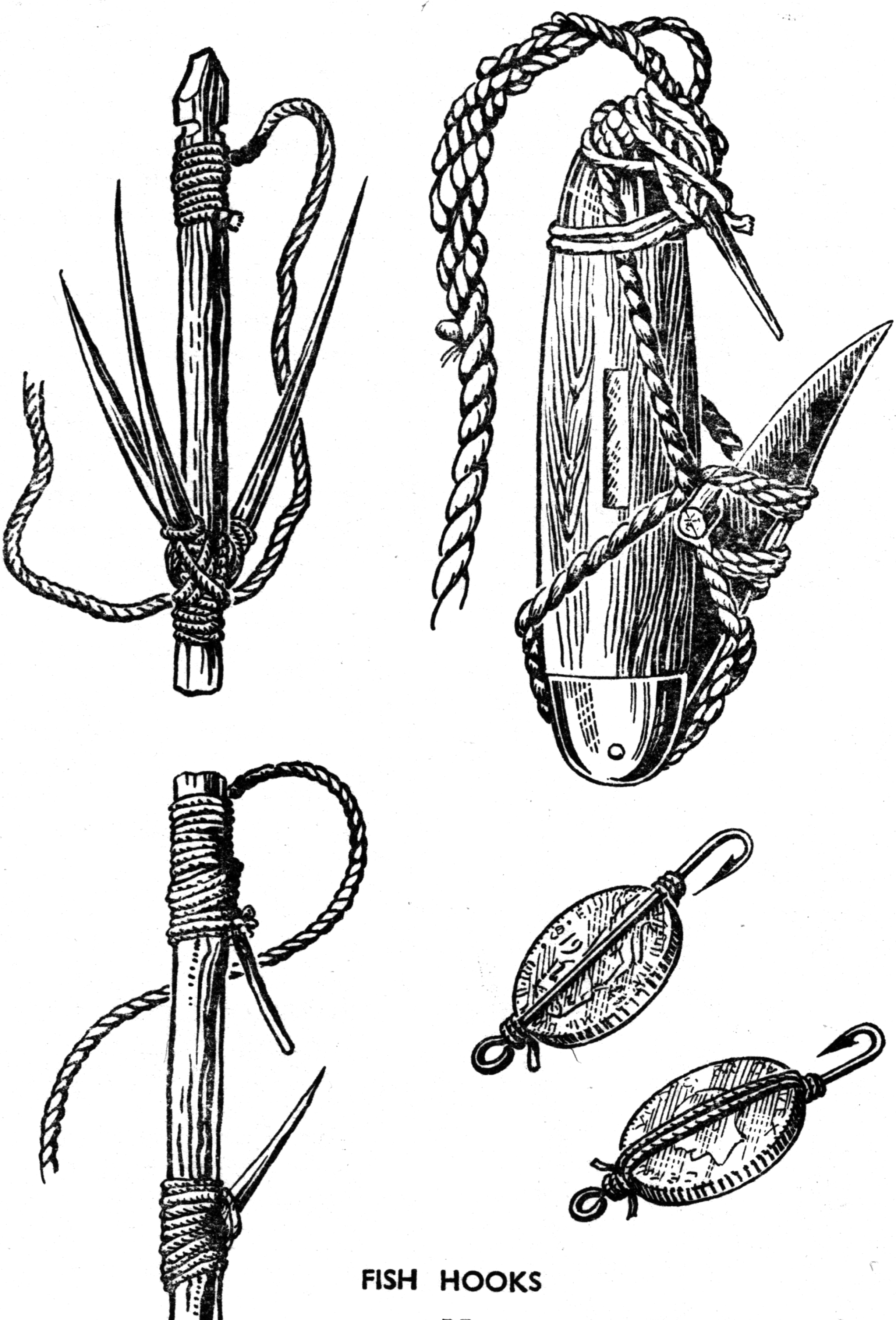
103. ***Ants, Grubs, etc.*** Natives consider the white ant as a delicacy, either cooked or raw, with the wings removed. Also the white grubs of wood-infesting beetles are edible, and will be found quite palatable, if split and broiled over a fire. They will be found in decaying and rotten wood. Such insects as grasshoppers and crickets may be toasted over a fire, the wings and legs having first been removed.



EDIBLE INSECTS

104. ***Animals.*** Too much reliance should not be placed on animals as a source of food. They are not only difficult to catch,

but finding them in the first place may present quite a problem, and killing them and disposing of the flesh will also need considerable thought. Those animals most easily found and caught are probably the various species of deer and wild pig but you will need a gun to kill them. A bow and arrow will kill small birds and animals; you can catch others in traps.



FISH HOOKS

FISH HOOKS

Fish

105. All areas of water, lakes, streams, and rivers contain a variety of life, most of which will be found to be edible. If camping in the vicinity of water there should be no danger of shortage of either food or water—fresh or purified—all of which can be obtained from such a source. Animal life is more abundant in water than on land, and generally speaking, is more easily caught. The chances of survival along a body of water are always excellent, and fish may be caught with crude equipment, if you know when, where, and how to fish.

106. ***When to Fish.*** Different species of fish feed at all times of the day or night, though there are many governing factors relating to feeding activity; however, in general, early morning and later afternoon are the best times to fish with bait. Fish rising or jumping are sure signs of feeding.

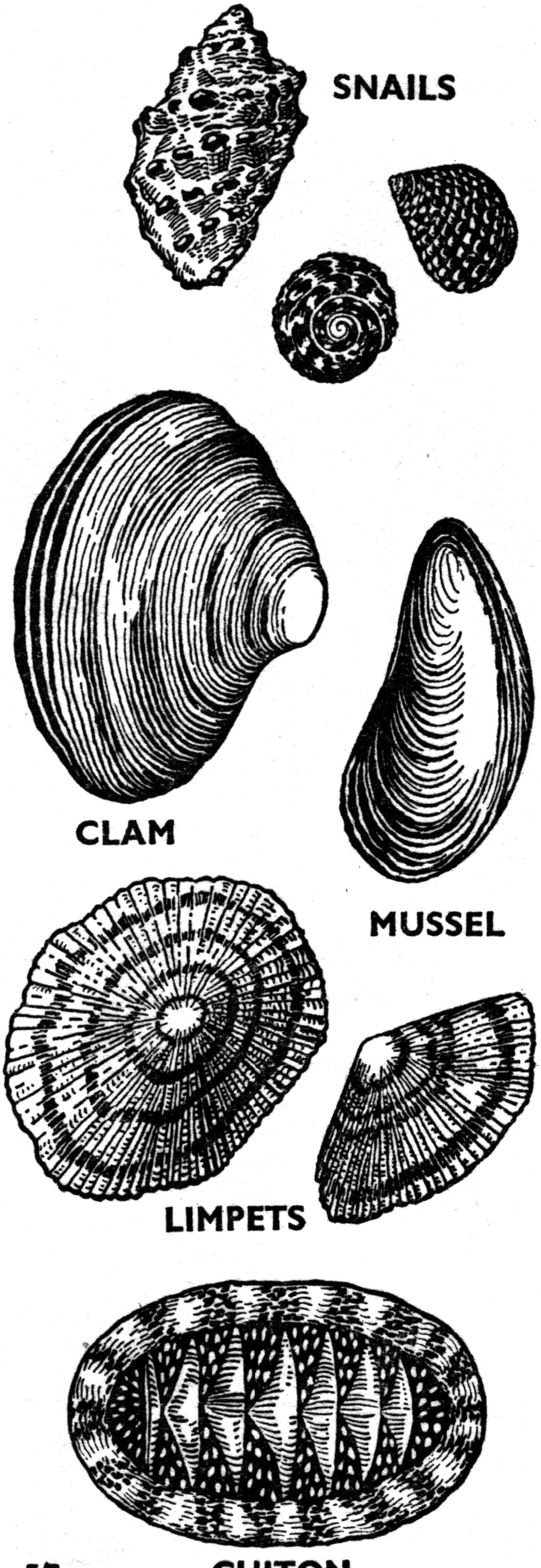
107. ***Bait.*** Experiment with bait, and try to obtain your baits from the water, as such bait will be more natural. Such life as insects,

shrimps, worms grubs, small minnows, or even the meat of a jellyfish, are all good bait ; in addition the wasted parts of the fish themselves, that is the eyes, head, intestines. If a certain type of fish appears plentiful, having caught the first one, open it up and find out on what it feeds, and endeavour to find a similar bait.

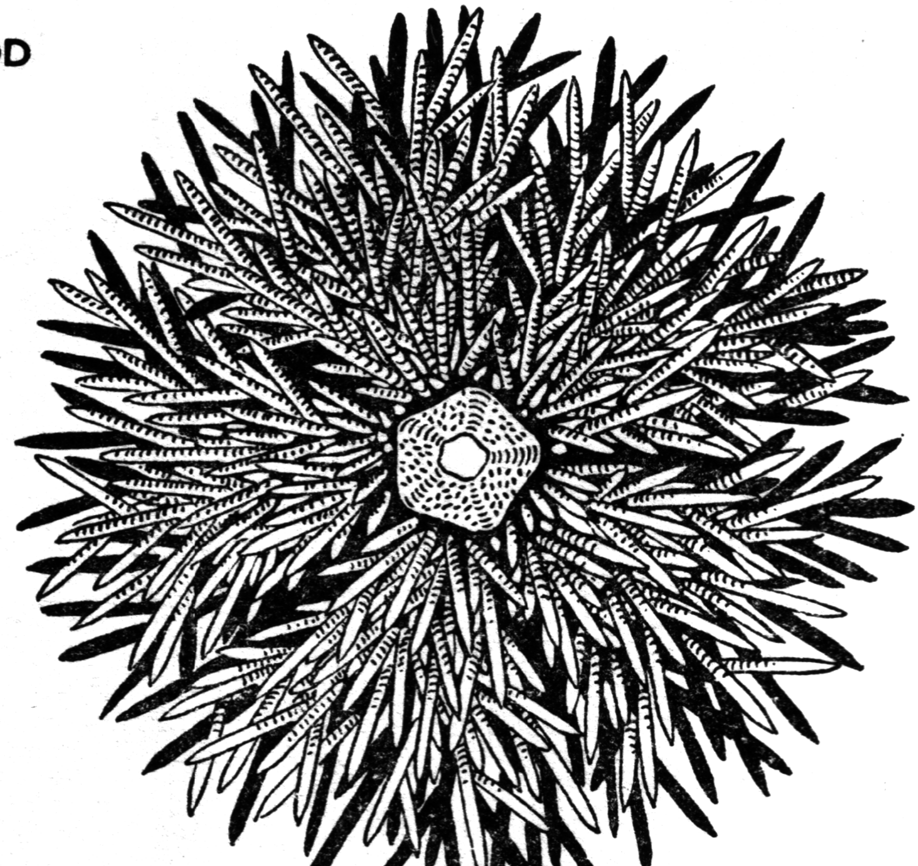
108. ***Technique.*** Try to conceal the hook in the bait, and approach the fish upstream, as they normally lie heading into the current. In clear shallow water, move slowly to avoid frightening, and if unsuccessful, try fishing after dark.

109. ***Hooks and Lines.*** Hooks can be made from pins, needles, wire, or any pieces of available metal ; fishing gear can also be made from wood, bamboo, bones, large thorns, or a combination of these ; see illustrations. Lines can be made from a great variety of plants, or the wiry stems of high climbing ferns, and the inner bark of trees, or the skin of the banana tree-trunk. For added strength a number of these can be twisted or platted together.

EDIBLE SEA FOOD

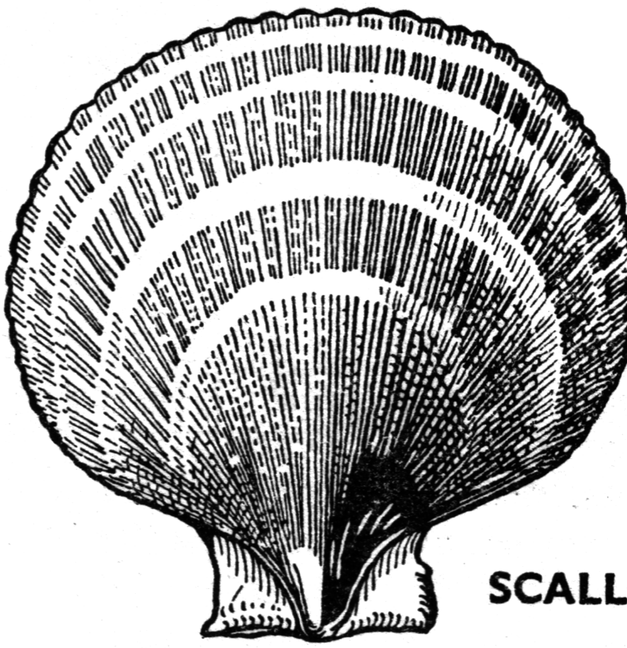


EDIBLE SEA FOOD

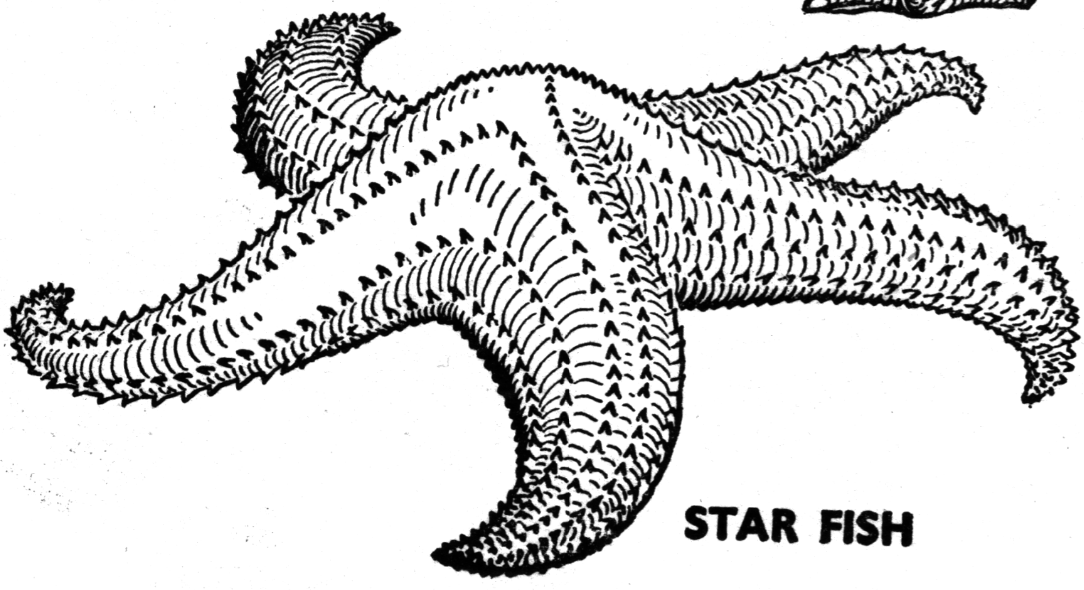


SEA URCHIN

SEA CUCUMBER



SCALLOP



STAR FISH

110. ***Crustaceans.*** Crabs, crayfish, lobsters, shrimps, and prawns are found in fresh water throughout the world; all of them are edible, though they will spoil quickly. As is the case for all types of fresh water fish, the crustaceans contain parasites harmful to man, and must always be cooked before serving. Many species are nocturnal in their habits, and may be caught more easily at night. All the meat within the skeleton of crabs, crayfish, and lobsters can be eaten, but the gills are usually discarded. Fresh water shrimps are abundant in tropical streams, and can be seen swimming or found standing stationary on the rocks and the sand of the stream bed. Look for them in the quieter parts of a stream where the water is sluggish. They can be caught quite easily with a small cane, with a loop at the end made from the skin or bark of a tree. The idea is to drop the loop over the eye of the shrimp, which protrudes from its head, and with a quick movement the shrimp is caught in the loop. They will rise to the surface at night, if a light is placed close to the surface, and may be scooped off.

111. ***Fish Traps.*** A simple and very useful fish trap, capable of catching all types of creatures found in fresh and salt water, can be made from two pieces of bamboo. The scheme is to obtain one small piece about a foot in length, and another rather larger and somewhat longer piece, perhaps about two feet. Split each piece down from the top, leaving the bottom intact, force the ends out to form a cone, and then place one cone inside the other, attaching the edges together with cord, or some fine flexible vine or rattan. A hole made in the smaller cone will turn this device into a simple "lobster pot", and two or three of these placed in the stream near to the camp will produce meals without time or effort being spent. (see illustration to para 127).

NATIVES

112. In peacetime you can expect natives to be friendly. In troubled areas you will be briefed of possible hostility before flight. The natives will, no doubt, know of your presence however quietly you may approach. If uncertain of your reception, send one member of the party into the village first. Whilst he is away, move to another position ; in the event of antagonism, it will be possible to get away before the natives appreciate that you have moved from your point of observation.

113. Having made contact, if receiving shelter or hospitality from

natives, throughout the time you are with them consider the following points :—

(*a*) Deal with chief, or headman, and ask, do NOT demand.

(*b*) Show friendliness, courtesy, and patience—don't be scared, as fear tends to make them hostile.

(*c*) Do not threaten or display weapons.

(*d*) Greet natives as you would your own kind.

(*e*) Make gifts of small personal belongings and trinkets.

(*f*) Take plenty of time when approaching either them, or their village.

(*g*) Make use of the sign language; when ready state your business briefly, and frankly.

(*h*) Treat natives like human beings, and don't "look down" on them ; after all, you will be wanting their help sooner or later.

(*j*) If you make a promise be sure to keep it.

(*k*) Respect local customs and manners.

(*l*) Endeavour to pay in some manner for what you take ; using tobacco, salt, razor blades, matches, cloth, empty containers, etc.

(*m*) LEAVE THE NATIVE WOMEN ALONE—only have contact with them when on "official business".

(*n*) Respect their privacy, do not enter their homes until asked.

(*o*) Learn their laws, and abide by them—bounds, animals, etc.

(*p*) Entertain and be a good audience.

(*q*) Take practical jokes in good fun.

(*r*) Try to pick up bits of their language ; they will appreciate your efforts, when you make use of some of their words.

(*s*) Avoid all leading questions—with the answer "yes" or "no".

(*t*) Learn their woodcraft, and the sources from which they obtain food and drink.

(*u*) If living amongst natives, endeavour to avoid personal contact with them as much as possible ; make your own shelter, and produce and cook your own food and drink.

(*v*) Always be friendly, firm, patient and, above all, honest.

(*w*) When you depart be sure to leave a good impression.

WELFARE SECTION

AFTER a hydrogen bomb attack, thousands would be homeless, hungry, exhausted and frightened. Help and comfort would come from the Welfare Section. Its members are training now for such tasks as evacuation and reception, emergency feeding, and running rest centres, information centres and mobile canteens.

An Emergency Feeding Unit with an improvised hot-plate cooker.

CIVIL DEFENCE CORPS.

10. The Welfare Section are trained to look after the homeless, organise and escort parties of evacuated children. They also run information centres.

Prepared by Dr. William Chipman DCPA

July 13, 1979

(WRITTEN 2 DAYS BEFORE DCPA BECAME FEMA ON 15 JULY 1979)
Dr William Chipman

CIVIL DEFENSE FOR THE 1980's--CURRENT ISSUES

ABSTRACT:

Presidential Decision 41. PD 41 makes it clear that CD is a factor to be taken into account in assessing the strategic balance: The U.S. program is to "enhance deterrence and stability," and to "reduce the possibility that the Soviets could coerce us" in a crisis.

Civil Defense and the Cuban Crisis **PAGE 47**

There is a final point worth making with respect to civil defense and crises. In a 1978 interview, Steuart L. Pittman, who was Assistant Secretary of Defense for Civil Defense in 1961 to 1964, pointed out:

> [I]t is interesting that President Kennedy personally raised the civil defense question during the Cuban crisis. He was considering conventional military action against Cuba to knock out the missile sites. I understand he was the only one of the "Committee" to raise the issue of civil defense, which tells us something. He asked whether it would be practical to evacuate Miami and other coastal cities in Florida. . . . I was called into the marathon crisis meeting and had to tell him that it would not be practical; we did not have any significant evacuation plans. . . . The President dropped the idea, but shortly after the crisis was over, his personal concern over his limited civil defense options led him to sign a memorandum directing a significant speedup in the U.S. civil defense preparations. (Emphasis added.)93/

While history seldom repeats itself exactly, it does indeed "tell us something" that in the only overt nuclear confrontation the world has

93/Op. cit. supra note 73 at 152-153.

yet seen, the American President was concerned about civil defense--and that the idea of population relocation during the crisis was one of his specific concerns. Certainly it is clear that in 1962, the notion of vulnerability being stabilizing held little attraction for the Chief Executive. And as outlined below (in discussion of CD and SALT), the notion that vulnerability is desirable has never commended itself to Soviet leaders.

73/Sullivan, Roger J. et al, The Potential Effects of Crisis Relocation on Crisis Stability, System Planning Corporation, Arlington, Virginia, September 1978.

Richard Titmuss's classic study of civil defence in the Second World War, "Problems of Social Policy", 1950, made the case that the postwar social state originated in the wartime civil defence system to care for millions of bombing evacuees and families who lost their homes.

[See: John Welshman, "Evacuation and Social Policy ... ", Twentieth Century British History (1998) 9 (1): 28-53.]

Number and Classification of Official Evacuees in Great Britain in 1939 and 1940

900,000 of the 1.5 million returned to the target areas after four months of war.	September, 1939		January, 1940	
	Number	Percentage Distribution	Number	Per cent of Those in September, 1939
1. Unaccompanied school children	826,959	56.1	457,600	55
2. Mothers and accompanied children	523,670	35.5	64,900	12
3. Expectant mothers	12,705	0.9	1,140	9
4. Blind persons, cripples, and other special classes	7,057	0.5	2,440	35
5. Teachers and helpers	103,000	7.0	46,500	45
Total	1,473,391	100.0	572,580	39

Source: R. M. Titmuss, *Problems of Social Policy* (London: H.M. Stationery Office, 1950), pp. 103 and 172.

IMPORTANT ANNOUNCEMENT

DISPERSAL OF CIVILIAN POPULATION

....**COUNCIL**

The Government have announced that the voluntary dispersal of the following classes of persons from this area* to reception areas in other parts of the country shall be put into effect immediately.

1. CHILDREN UNDER 15
Children of this age must be taken by their mothers, or by another responsible adult if their mother cannot go. Only in most exceptional circumstances will children be allowed to go on their own. (EXAMPLE : if neither of their parents can go because of illness and there is no one else to take them.)

2. CHILDREN BETWEEN 15 AND 18 STILL AT SCHOOL FULL-TIME
Children in this class may either go with their mothers or on their own. In exceptional circumstances they may go with another responsible adult. (EXAMPLE : a handicapped child whose mother is too ill to go.)

3. CHILDREN BETWEEN 15 AND 18 WHO HAVE LEFT SCHOOL
Children in this class should go on their own. Only in exceptional circumstances may they be accompanied. (EXAMPLE : if they are handicapped, or if the mother is taking younger children.)

4. EXPECTANT MOTHERS

5. BLIND, CRIPPLED OR AGED AND INFIRM PEOPLE *only* if they are dependent on the care of a person who is a member of the classes mentioned above and who is travelling under the scheme.

Special arrangements are being made for the dispersal of children under the age of 18 who are resident at boarding schools, homes or other similar establishments. Parents who do not wish their children to take part in such arrangements should immediately contact the establishments.

Children in the care of a local authority who are living with fosterparents are included in the above classes. If their fosterparents are unable to go with them the Child Care Authority should be informed at once.

Anyone living in the area of..who comes within the above priority classes and wishes to take part in the scheme should go immediately to

..where they will be given further instructions.

CLERK OF THE COUNCIL

***If only part of the area is within the dispersal scheme, the districts affected are shown below:**

UK National Archives: HO 225/54 and CAB 21/4053

HOME OFFICE

SCIENTIFIC ADVISERS' BRANCH

The Circulation of this paper has been strictly limited. Mr Shath

It is issued for the personal use of ......

SECRET

CD/SA 54

Copy No. 54

Some Aspects of Shelter and Evacuation Policy to meet H-Bomb threat

---

The simplest way of specifying shelter performance is by means of the "Safety Rating" concept developed in CD/SA 48. The safety rating of a shelter was there defined as the saving in life, expressed as a percentage of the deaths without shelter, resulting from the use of the shelter in an area of uniform population density. This shelter with a safety rating of 80 would save 80% of the lives that would have been lost if everyone had been in a house. Put in another way, shelter with a safety rating of 80 would reduce the area within which deaths occurred to one fifth of that for people in houses, and therefore the radius of death to $\frac{1}{\sqrt{5}}$. For a bomb with a power factor of F the equivalent radius of death if everyone is in a shelter with a safety rating of 80 will therefore be $\frac{0.6\,\sqrt[3]{F}}{\sqrt{5}}$. Similarly for shelter with a safety rating of 90 the radius will be $\frac{0.6\,\sqrt[3]{F}}{\sqrt{10}}$.

Although, as stated above, the design details of shelters to give these safety ratings have not been determined, it seems probable that surface or trench shelters of rather less than Grade A strength (say 1000 lb/sq.ft.) would be required to give a safety rating of 80, and that a strength of about 2000 lb/sq.ft. would be required for a safety rating of 90. For small street surface shelters the extra cost of an increase in strength of this sort is very small (e.g. the structural cost of a 12"/1000 lb/sq.ft. design is given in CD/SA 48 as £15.2 per person, based on seated capacity) and of a 12"/1400 lb/sq.ft design as £15.5 per person) and detailed studies may well show that shelters with a higher safety rating than 90 are a practical proposition.

(N = 20 kt)

Table 3

Deaths with no evacuation but with everyone in a shelter with a Safety Rating of 90

City	Power of bomb		
	100N (2 Mt)	500N (10 Mt)	1000N (20 Mt)
London	59,000	216,000	367,000

The considerations discussed above strongly suggest that the right policy against the hydrogen bomb would be to evacuate the central areas of our larger cities and to provide shelter where it is most useful, i.e. in the annulus surrounding the central evacuation area.

CD/SA 48 = Nat. Archives HO 225/48

Table 4

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter having a safety rating of 80.

20 Mt

City	Position of bomb		
	Central	2 miles from centre	In position to cause maximum deaths
London	0	0	518,000
Birmingham	0	159,000	256,000
Glasgow	0	171,000	247,000
Liverpool	0	174,000	247,000
Manchester	0	164,000	257,000
Total	0	668,000	1,525,000

Table 5

Deaths from 1000N bombs after evacuation of 5 mile radius circle for London and 3 mile radius for other cities. Evacuees assumed accommodated in surrounding annulus where they and the original inhabitants are provided with shelter with a safety rating of 90.

20 Mt

City	Position of bomb		
	Central	2 miles from centre	In position to cause maximum deaths
London	0	0	261,000
Birmingham	0	56,000	155,000
Glasgow	0	64,000	152,000
Liverpool	0	67,000	152,000
Manchester	0	62,000	151,000
Total	0	249,000	871,000

It will be seen from Tables 4 and 5 that, with this scheme of total evacuation of a central area and shelter in the surrounding annulus, a central bomb causes no deaths at all. Clearly, however, the enemy would be aware of our provisions and might well choose to drop his bombs where they would cause maximum casualties. On average, and without allowing for local concentrations which would be bound to occur in the "reception annulus", this would be at about 7 miles from the centre in the case of London and about 4 miles for the other cities. The average deaths from bombs in these worst positions are therefore given in Tables 4 and 5. Comparing these figures with those to Table 1 it will be seen that evacuation plus shelter with a safety rating of 80 has reduced deaths by 82%, and plus shelter with a safety rating of 90 by 90%.

Conclusion

Without shelter or evacuation, the deaths from an attack with only five hydrogen bombs might total over $8\frac{1}{2}$ million. The primary object of Civil Defence must be to reduce this figure. Neither evacuation alone nor shelter alone could reduce these deaths to a manageable proportion, but with a suitable combination of the two, consisting of the total evacuation of the population of the central areas into the surrounding annuli where shelter would be provided, it should be possible to reduce the maximum deaths from this particular attack to something of the order of one million.

April, 1954.

E.L.W.

OSA.41/4/32.

E. L. W. = Edward Leader-Williams (who in WWII tested the Morrison shelter while John Fleetwood Baker's colleague)

REFERENCES:

CD/SA 48 = Nat. Archives HO 225/48, "The safety-cost relationship for certain types of surface and trench shelters"

CD/SA 72 = Nat. Archives HO 225/72, "Casualty estimates for ground burst 10 megaton bombs"

JOINT SERVICE MANUAL
OF
HOME DEFENCE

CHAPTER INDEX

PART I - BACKGROUND TO HOME DEFENCE

CHAPTER 1

INTRODUCTION TO HOME DEFENCE

"The phoenix of mythology re-juvenated itself in flames, rising from its own ashes to a new life. The flames of a future war may, or may not be of our own creating and, in a nuclear conflict, will certainly be more than a little hot. The ultimate purpose of Home Defence is to ensure that we are able to rise phoenix-like from the ashes of a nuclear conflagration and that any lack of preparation does not result in the death of the bird - our nation."

SECTION 1. INTRODUCTION

NCE ACT 1948

FORMS OF ATTACK

123. The current assessments point clearly to nuclear was as the overriding consideration in determining the preparations to be made for home defence in the United Kingdom. Whilst it is possible that chemical weapons and, to a lesser extent biological warfare, could be used against selected vitally important civil and military installations, their use against the civil population as a whole is considered most unlikely. The use of aircraft and missiles armed with non-nuclear devices against selected targets cannot be discounted, but most of the measures taken in the context of a nuclear war would be of equal relevance to a war which began with conventional weapons.

EFFECTS OF ATTACK

124. As with the warning period, the scale and pattern of attack cannot be determined with precision but, whatever the scale, an attack by thermo-nuclear weapons directed against civil and military installati and against centres of population, with the attendant threat of widespre radioactive fall-out, would result in enormous casualties and extensive damage. Although estimates can be made of local casualties and of damage caused by varying attack patterns, no probability can be given to any one group of attack patterns. Nevertheless, solely for the purpose of survival planning, it can be assumed that the population survival rate would range from 60% in the worst affected areas to 95% in the least affected areas. On the other hand, loss of essential services and productive capacity due to installation damage, loss of power supplies and lack of raw materials, could be as high as 80%. These figures are merely indicative of the possible scale of the effe of nuclear war.

SECTION 1. INTRODUCTION

201. This chapter is not intended to be a comprehensive assessment of the threat to the United Kingdom. It merely sets the scene within which the subject of Home Defence can be studied. Those requiring a greater depth of knowledge must turn to available classified publicati A basic knowledge of the effects of nuclear explosions is assumed and can be obtained from pamphlets listed in the Bibliography (Annex C to the Manual).

202. The overall threat can be divided into the following:

a. Internal Threat - sabotage and subversion.

b. Conventional attack.

c. Nuclear attack.

d. Chemical attack.

e. Biological attack.

03. Current assessments point clearly to nuclear attack as th verriding consideration in determining the preparations to be ma or Home Defence in the United Kingdom and this must be accepted basic planning assumption. Planning to deal with the other f ... is necessary as they may form a prelude or part of a n

targets but also ... will and ... to tie down la
weaken the national will and ...

208. One result of sabotage would be to tie down la
men on static guard duties thereby preventing them fro
other necessary tasks.

SUBVERSION

209. There exist in this country certain dissider
which are known to be in sympathy with our potential
can be expected to react against the good of the nat
tension. These groups are small and for the most p
influence. Moreover, it is likely that their numbe
enemy were seen to be about to attack us. However
especially that of the IRA, should not be underesti

210. The threat posed by subversive groups inclu
in key industries, promoting anti-war demonstration
against the Government and disruptive activities co
preparations.

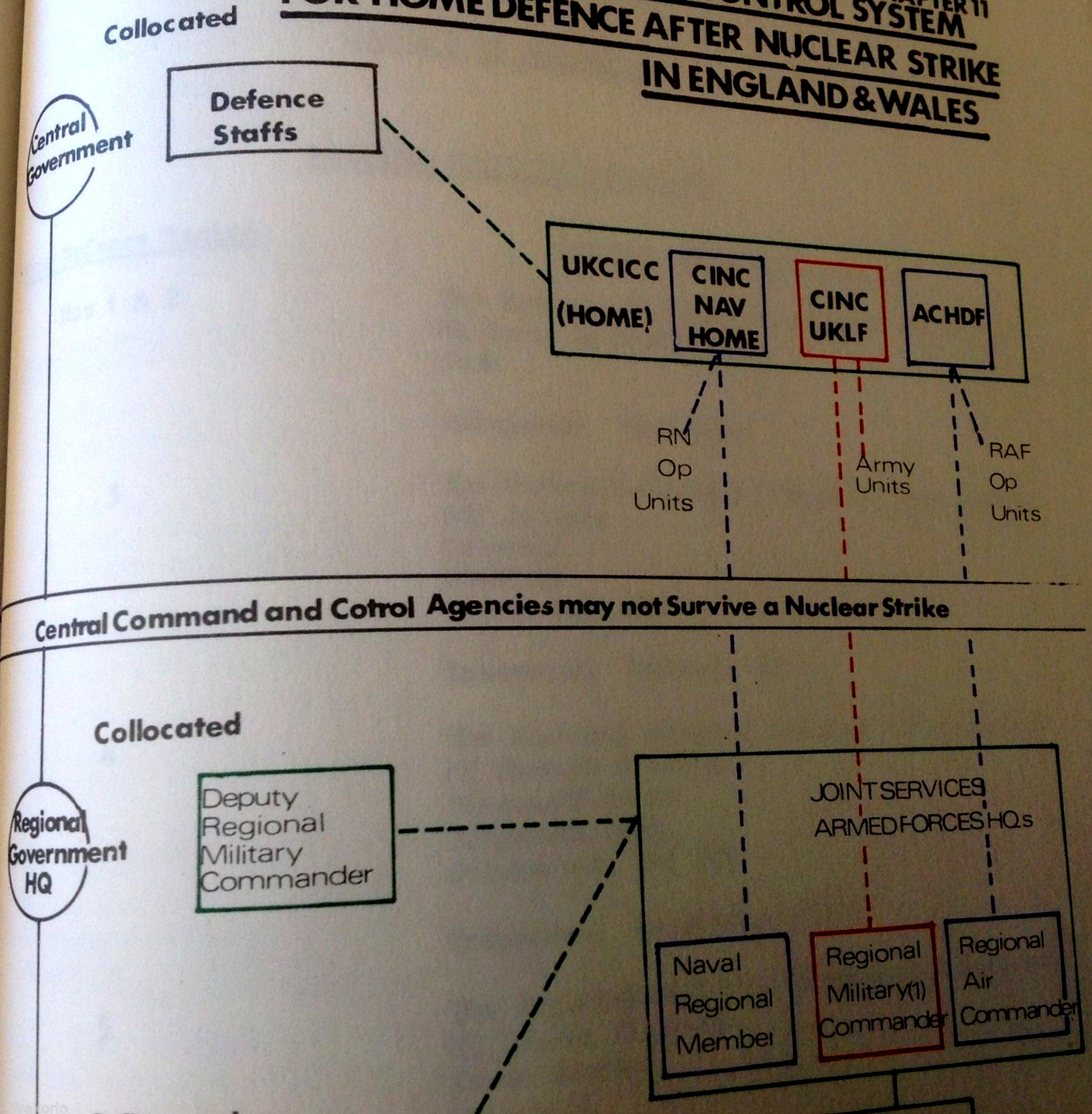
SECTION 6 - INFORMATION TO THE PUBLIC IN WAR

INTRODUCTION

1056. The question of what the public should be told and when is an extremely difficult one. Certain announcements can be prepared for issue in a period of tension and post strike. The timing of their issue cannot, however, be accurately pre-planned and will largely be a matter for decision in the event.

1057. The two conflicting issues in retaining the full cooperation of the public are firstly to avoid any sort of panic possibly leading to a mass movement of population and secondly to ensure that sufficient warning is given to allow necessary preventative and later survival action to be taken.

JOINT SERVICE COMMAND & CONTROL SYSTEM FOR HOME DEFENCE AFTER NUCLEAR STRIKE IN ENGLAND & WALES



JIC(68) 4 (Final)

22nd January, 1968.

EMPLOYMENT OF SOVIET FORCES IN THE EVENT OF GENERAL WAR UP TO THE END OF 1972

Report by the Joint Intelligence Committee

INTRODUCTION

The likelihood of war with the Soviet Union and the ways by which it might come about are examined in our reports JIC(65) 87 (Final) and JIC(66) 77 (Revised Final) in which we concluded that "the Soviet leaders will not deliberately start a general war and are most unlikely deliberately to start a limited war". We also concluded that war between the Soviet Union and the West could result from miscalculation, but that this was unlikely. Notwithstanding these assessments there is a requirement to provide views on how the Soviet armed forces might be employed in the event of general war.

2. In examining this problem we assume that a critical situation in some part of the world has given rise to a period of mounting tension between the Soviet Union and the West; and that as a result of a process of miscalculation the Soviet Union decides on all-out war, including a full-scale strategic nuclear attack. Probable plans for the employment of Soviet armed forces in this latter circumstance are discussed below.

3. We believe that the overriding Soviet aim in general war would be to limit damage to the Soviet Union to the greatest extent possible. With this in mind, their military objectives are likely to be -

(a) Primary Objective
To destroy as much as possible of the Western strategic offensive capability and the Western will to fight;

(b) Secondary Objective
To engage and defeat such other Western military forces as remained, in order subsequently to extract any possible advantage for the Soviet Union.

8. It would seem logical therefore for the Russians to conclude that, having covered those nuclear strike force and air defence targets which are susceptible to attack, the most profitable targets in the United States would be those related to the aim of destroying the will and ability of the government and people to continue the war. These would include centres of governmental and military control and concentrations of industry and population.

9. In Europe, all worthwhile targets in NATO countries, including the United Kingdom, can be covered by the large MRBM/IRBM and medium bomber forces located in Western Russia.

WEAPONS SYSTEMS

ICBMs

10. ICBMs would be used against targets in North America; they have the advantage of giving a shorter warning time than aircraft and are suitable for the engagement of static targets. In addition to the systems now being deployed, there are several development projects under way which could result in operational systems during the period. A Fractional Orbit Bombardment System (FOBS) has been undergoing regular research and development testing and may be deployed as an operational system. If so it would add to the diversity of Russia's strategic threat, reduce warning times and make target prediction more difficult. A solid propellant ICBM is also believed to be under development, and mobile ICBM concepts are being investigated by the Russians. If deployed the mobile systems would supplement systems in permanent sites; solid propellant ICBMs might be deployed in new sites or installed as replacement missiles at existing sites.

MRBM/IRBMs

11. MRBM/IRBMs have sufficient accuracy and warhead yield, together with short warning time, to be suitable for use against Western nuclear strike forces in Europe all of which are at present unhardened. They are also suitable for use against major cities, industrial targets and centres of control.

12. MRBMs would normally be launched from permanent sites. However, the Russians have constructed a large number of "field" type launch positions in the vicinity of permanent soft MRBM sites. These "field" sites are believed to have no permanent facilities but to consist of

CONFIDENTIAL

Figure 3 The Balance of Nuclear Forces End-1982 [1,2.]

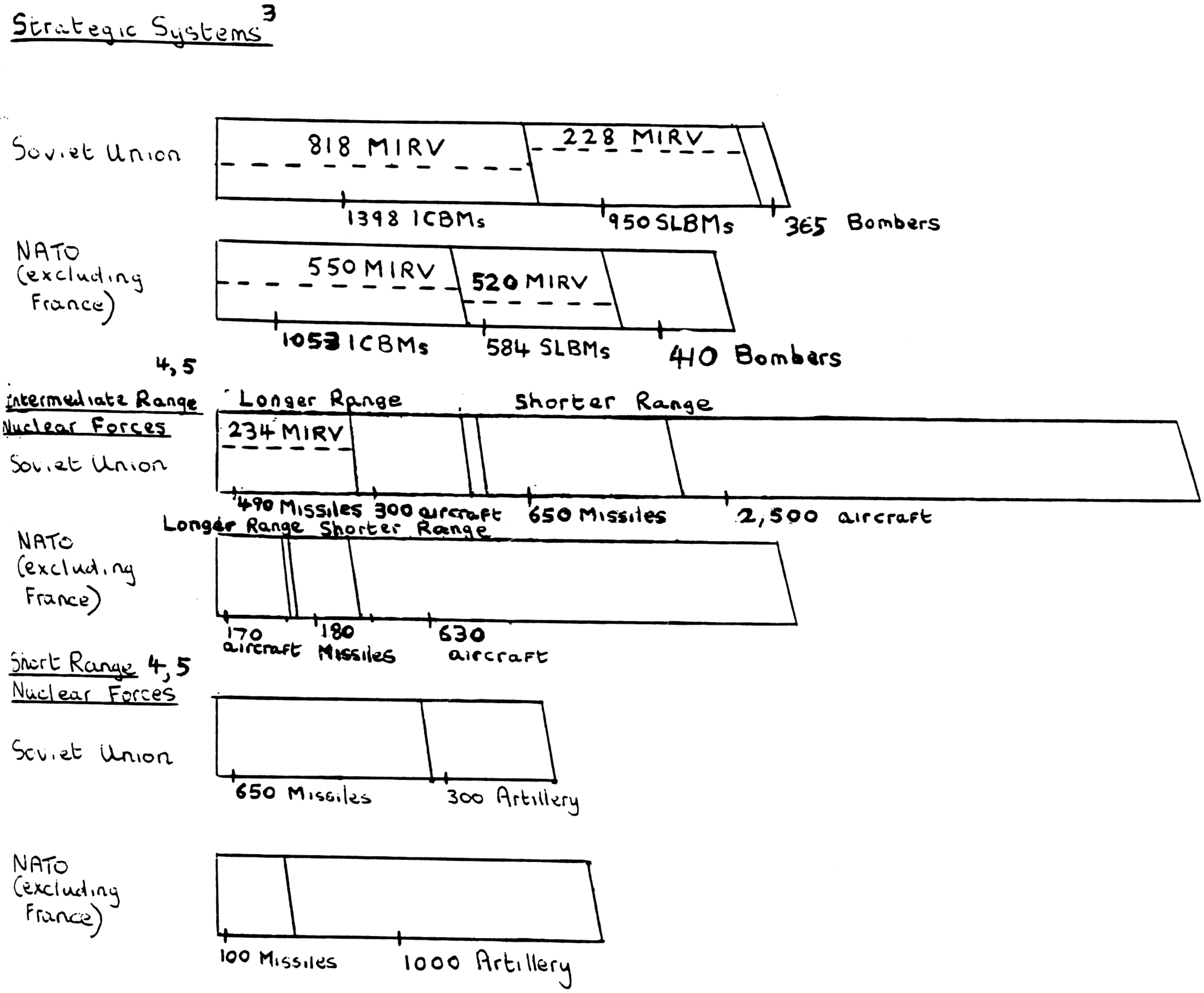
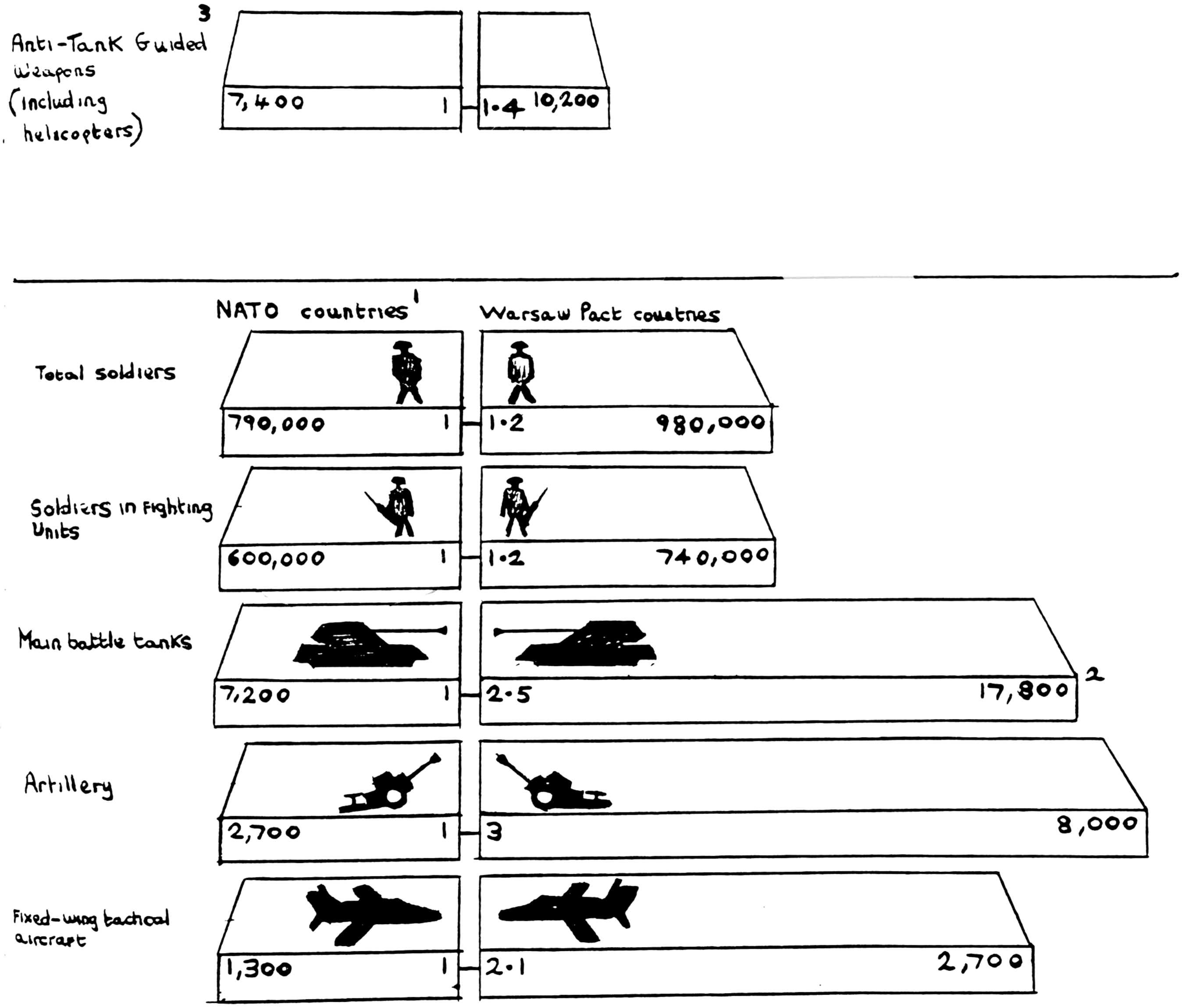


Figure 4

The Current Balance of Forces on the Central Front



1 Including French forces in the Federal Republic of Germany but excluding the Berlin garrison, which is not declared to NATO

2 Includes some Warsaw Pact tanks in training units and storage which would be available for operational use

3 Weapons which are, or have the capability of being, vehicle or helicopter mounted.

CIVIL DEFENCE
INSTRUCTORS' NOTES

Welfare Section

Part III

Evacuation and Care of the Homeless

CIVIL CD DEFENCE

PUBLISHED FOR THE HOME OFFICE
AND MINISTRY OF HOUSING AND LOCAL GOVERNMENT
BY HER MAJESTY'S STATIONERY OFFICE

HOME OFFICE

MINISTRY OF HOUSING AND LOCAL GOVERNMENT

(published in August 1960)

Civil Defence Instructors' Notes

WELFARE SECTION

PART III

DISPERSAL

~~Evacuation~~ and Care of the Homeless

(NOTE: contrary to propaganda from CND, New Statesman's Duncan Campbell, and the USSR's "World Peace Council", civil defence evacuation in Britain helped to deter a Nazi "knockout blow" air raid: BEFORE we declared war on 3 September 1939 we evacuated children from London in "Operation Pied Piper". This is hard fact.)

LONDON

HER MAJESTY'S STATIONERY OFFICE

1960

PRICE 2s. 6d. NET

BILLETING SURVEY FORM

District.. Ward or Parish..

1 Address ....

....

2 Name of Householder..

3 Number of habitable rooms........................

		Adult	Children (age)	
4 Number of persons ordinarily resident	Male	....	....	....
	Female	....	....	....

5 Is the house suitable for (*a*) Unaccompanied children..

(*b*) Aged-infirm ....

(*c*) Handicapped ....

(*d*) Expectant mothers ....

6 Is the householder willing to take unaccompanied children?...

7 Has the householder any spare beds, bedding, or other equipment?..

8 Any other comments (e.g. old age or infirmity of householder, etc.) ....

....

....

....

....

....

Date of visit.. Signature of visitor..

REGISTRATION OF PRIORITY CLASS EVACUEES

PLACE OF REGISTRATION..

SHEET No....................

COUNCIL..

TRAIN PARTIES

	Family Groups (including Adolescents)				Unaccompanied Children		
	Surname	Adults	Children	Total	Surname	Total Over 5	Total Under 5
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

REGISTRATION OF PRIORITY CLASS EVACUEES

PLACE OF REGISTRATION..

SHEET No....................

COUNCIL..

SPECIAL TRANSPORT

Surname Mr. Mrs. Miss	Address	Reason for Special Transport

HOMELESS PERSONS

PRELIMINARY REGISTRATION

(To be made as early as possible)

Date..

PLACE OF REGISTRATION.. SHEET NO..............................

	Surname of Family	Adults		Children Under 15	Home Address	Other Information
		Male	Female			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						

REST CENTRE REGISTER

Date ....

NAME OF REST CENTRE.. COUNCIL... SHEET NO.................................

	Surname	Christian Name(s)	Sex	Home Address	Address Whence Admitted (If Different)	Date of Departure	Destination (X If Officially Billeted)	Other Information
1	2	3	4	5	6	7	8	9
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

CLOTHING EMERGENCY ISSUE FORM

Place of Issue..

Date..

Name ....

Address..

....

....

Number served in family..

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
MEN'S	*Over-coats*	*Trousers*	*Jerseys*	*Jackets*	*Shirts*	*Vests*	*Pants*	*Socks*	*Night-wear*	*Dressing Gowns*	*Boots Shoes*	*Welling-tons*	*Mackin-toshes*	*Braces Belts*	*Suits Battledress*	*Unclassified*
WOMEN'S	*Over-coats*	*Skirts*	*Jerseys Jackets*	*Dresses*	*Blouses*	*Vests*	*Knickers*	*Stock-ings*	*Night-wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Belts Corsets*	*Costumes Battledress*	*Unclassified*
BOYS'	*Over-coats*	*Shorts*	*Jerseys*	*Jackets*	*Shirts*	*Vests*	*Pants*	*Socks*	*Night-wear*	*Dressing Gowns*	*Boots Shoes*	*Welling-tons*	*Mackin-toshes*	*Braces Belts*	*Suits Battledress*	*Unclassified*
GIRLS'	*Over-coats*	*Skirts*	*Jerseys*	*Dresses*	*Blouses*	*Vests*	*Knickers*	*Stock-ings*	*Night-wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Belts*	*Costumes Battledress*	*Unclassified*
UNDER 4's	*Coats*	*Shorts Skirts*	*Jerseys*	*Suits Dresses*	*Shirts Blouses*	*Vests*	*Pants Pilches*	*Socks*	*Night-wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Bodices*	*Nappies*	*Layettes*

Signature of Recipient..

Signature of Member Issuing..

CLOTHING REQUEST FORM

No.:....................................

To...Supply Depot

From (Place)...

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	
MEN'S	*Over-coats*	*Trousers*	*Jerseys*	*Jackets*	*Shirts*	*Vests*	*Pants*	*Socks*	*Night Wear*	*Dressing Gowns*	*Boots Shoes*	*Welling-tons*	*Mackin-toshes*	*Braces Belts*	*Suits Battle-dress*	*Unclassified*	*Remarks*
Requested																	
Sent																	
WOMEN'S	*Over-coats*	*Skirts*	*Jerseys Jackets*	*Dresses*	*Blouses*	*Vests*	*Knickers*	*Stock-ings*	*Night Wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Belts Corsets*	*Costumes Battle-dress*	*Unclassified*	*Remarks*
Requested																	
Sent																	
BOYS'	*Over-coats*	*Shorts*	*Jerseys*	*Jackets*	*Shirts*	*Vests*	*Pants*	*Socks*	*Night Wear*	*Dressing Gowns*	*Boots Shoes*	*Welling-tons*	*Mackin-toshes*	*Braces Belts*	*Suits Battle-dress*	*Unclassified*	*Remarks*
Requested																	
Sent																	
GIRLS'	*Over-coats*	*Skirts*	*Jerseys Jackets*	*Dresses*	*Blouses*	*Vests*	*Knickers*	*Stock-ings*	*Night Wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Belts*	*Costumes Battle-dress*	*Unclassified*	*Remarks*
Requested																	
Sent																	
UNDER 4's.	*Coats*	*Shorts Skirts*	*Jerseys*	*Suits Dresses*	*Shirts Blouses*	*Vests*	*Pants Pilches*	*Socks*	*Night Wear*	*Dressing Gowns*	*Shoes*	*Welling-tons*	*Mackin-toshes*	*Bodices*	*Nappies*	*Layettes*	*Remarks*
Requested																	
Sent																	

Signature of member requesting.. Date..............................

Signature of member sending clothing.. Date..............................

Two copies to be sent to SUPPLY DEPOT which keeps one copy, and RETURNS the other with the clothing.

CLOTHING STOCK RETURN

PAGE..............................

	Date	A Over-coats	B Trousers Skirts	C Jerseys *Jackets	D Jackets Dresses	E Shirts Blouses	F Vests	G Pants Knickers	H Socks Stock-ings	I Night wear	J Dressing Gowns	K Boots Shoes	L Welling-tons	M Mackin-toshes	N Braces Belts Corsets	O Suits Costumes Battle-dress	P Unclassified
MEN'S Stock																	
Further stock received																	
Total																	
Total on stocktaking																	
Garments requested																	
WOMEN'S Stock																	
Further stock received																	
Total																	
Total on stocktaking																	
Garments requested																	
BOYS' Stock																	
Further stock received																	
Total																	
Total on stocktaking																	
Garments requested																	
GIRLS' Stock																	
Further stock received																	
Total																	
Total on stocktaking																	
Garments requested																	
UNDER 4's.		Coats	Shorts Skirts	Jerseys	Suits Dresses	Shirts Blouses	Vests	Pants Pilches	Socks	Night wear	Dressing gowns	Shoes	Welling-tons	Mackin-toshes	Bodices	Nappies	Layettes
Stock																	
Further stock received																	
Total																	
Total on stocktaking																	
Garments requested																	

* For women and girls.

(After stocktaking, start a new page, and carry forward " Total on stocktaking ")

THE PURPOSE OF ~~EVACUATION AND~~ CARE OF THE HOMELESS

A. Aims

1 *Care of the Homeless:* The provision of shelter and practical help for those who lose their homes or have to leave them because of enemy action.

~~2 *Evacuation:* To disperse part of the population before an attack, with the object of saving life.~~

B. Plans

3 *Care of the Homeless:* Plans for the temporary accommodation of the homeless are based on the use of existing buildings as rest centres in which the homeless can be lodged temporarily until they can be found more permanent accommodation in billets or requisitioned houses. The responsibility for providing rest centres lies with county and county borough councils who are responsible for the ordinary peace time welfare services. The responsibility for billeting and otherwise housing the homeless rests with county borough and county district councils who are the housing authorities in peace time. The decision to open rest centres in war would rest with the appropriate civil defence controller. County councils may delegate the day to day administration of the rest centre service to county district councils, in which case there will be a need for close liaison between the district council officer in charge locally and the chief rest centre officer of the county. The Ministry of Housing and Local Government is the Department responsible for rest centre service policy.

4 *Evacuation:* Evacuation policy is the responsibility of the Ministry of Housing and Local Government. It would be the responsibility of the Government as a whole to decide whether to put any previously prepared evacuation scheme into operation on the threat of war. They would have to consider whether there was time to complete the operation before war broke out.

Evacuation, like other defence planning, has to take account of the latest assessments of the type of attack that might be launched and the means of defence against it. At the present time the Government are reconsidering the proposals for the evacuation of 12 million members of the priority classes, which were announced in 1956. It may be assumed however that any future evacuation plans will have the following basic features:

(*a*) The country will be divided into evacuation, neutral and reception areas.

(*b*) Evacuation areas will be linked as far as possible with specific reception areas.

(*c*) The main movement will be by rail.

(*d*) There will be priority classes (e.g., women, children, the aged and infirm, blind, crippled, etc.).

(*e*) The scheme will be voluntary.

(*f*) The details of running it will be the responsibility of the following local authorities:

(i) In *evacuation* areas the county boroughs and county district councils will be responsible for assembling those to be evacuated and seeing that they are entrained (special arrangements will be made for the London area, under which the L.C.C. will be responsible).

(ii) In *reception* areas county councils will be responsible for the reception of evacuees at detraining points and for their onward transport to their reception areas. County district councils (and county boroughs) will be responsible for the local reception of evacuees, their billeting and their general welfare thereafter.

REST ~~AND RECEPTION~~ CENTRES

Rest Centres

2 (*a*) *Definition*

A building used for the temporary accommodation of homeless persons until such time as they can return to their homes or be billeted or otherwise rehoused.

(*b*) *Types of Rest Centres*

(i) *Planned Centres:* Those earmarked in advance. Some may be large buildings with good facilities (e.g. schools) and a certain amount of equipment immediately available. There may be an emergency meals centre in the same building.

MOVEMENT

Unplanned movement of homeless from a damaged area

4 (*a*) Despite exhortations to " stay put " under cover after a nuclear attack, there will inevitably be a number, perhaps a very large number, of people who will seek to escape from the damaged areas; others will be driven from their homes by fire or by the destruction of effective cover. The control of this movement of the homeless will be largely a matter for the police and wardens, aided by street leaders, whose aim will be (1) to get the homeless under cover in any available accommodation and (2) to keep them away from the essential services routes.

(*b*) It is likely that in damaged areas no trained help may be available from the Welfare Section, e.g., in temporary refuges where homeless have been directed in order to get them under cover quickly. In such cases reliance must be on self-help; the only amenities will be those which are to be found in the refuge or which are brought in by the occupants. Where it is possible for Welfare Section members to get to refuges where a number of homeless are known to have congregated they should do so and give what help they can under the existing circumstances. The most important problems are likely to be those connected with first aid, sanitation and water.

Movement from fall-out areas

5 (*a*) After nuclear attack, it may be necessary to evacuate everyone from areas in which radioactivity from fall-out exceeds a certain intensity. Such a movement will not be possible until about 48 hours after the attack, and it will then be carried out on instructions from the control organisation.

(*b*) Welfare Section members will be concerned with the arrangements for the reception of persons evacuated from such areas. The procedure to be followed will be similar to that for other homeless persons. Initially they will be accommodated in rest centres; later, as far as circumstances permit, they will be billeted. It must be remembered that the incidence of radiation sickness among persons evacuated from areas of intense radioactivity is likely to be high.

Notes on teaching WE 8

6 Reference may be made to the Manual of Civil Defence, Volume I, Pamphlet No. 2 " Radioactive Fall-out Provisional Scheme of Public Control " and to WE/WF 34 " Control of the Public in Radioactive Zones ". (See also Note WE/WF 3, Part II.)

7 Throughout this session emphasis should be on the need for speed because:

~~(*a*) Any delay in the evacuation movement might mean that thousands of people would remain at risk who might otherwise have been moved~~.

(*b*) In view of the danger of radioactive fall-out it is essential that homeless should be got under cover without delay; shelter in a damaged building is better than remaining in the open.

ARRANGEMENTS FOR MEDICAL CARE

Introduction

1 In time of war the number of doctors and trained nurses available would inevitably fall far short of the need. It follows therefore that many injuries and illnesses, where normally skilled medical aid would be sought, will have to be dealt with by untrained or semi-trained helpers. A great deal of this work will fall to the lot of members of the Welfare Section and it is essential that all volunteers should acquire as much experience as possible in Home Nursing and First Aid. As far as possible families should be kept together and should tend each other.

Rest Centres

2 Rest centres will be working under conditions of great stress but must have space set aside for homeless persons requiring nursing care or first aid. The proportion of the accommodation of a rest centre which will be needed at any one time for this purpose will vary initially according to the location of the centre, and later, to the demands placed upon it.

In rest centres near the area of damage, it is likely that a large number of the homeless will need early treatment in some form or other. In addition if a Forward Medical Aid Unit is working in the vicinity some of the less seriously injured and psychiatric casualties who have passed through and have been discharged by the Unit will be homeless and may need further care at the rest centre.

The length of time the casualties will have to remain in the rest centres will depend on circumstances but in some instances it may have to be for a considerable time. Help in caring for casualties should be obtained from members of the patient's family or able-bodied homeless with particular skill and experience. When circumstances permit, advice and some assistance may be available to the rest centre staff from general practitioners and local authority nurses in the area.

Clearance from Z Zones *

3 Persons cleared from Z Zones will normally be brought to rest centres and the procedure for meeting their immediate needs and for billeting will be as for any other homeless. It must be remembered, however, that among those brought out from the Z Zone some will have received a large dose of radiation and may be expected to develop radiation sickness. Cases of radiation sickness will not normally be admitted to hospital since treatment consists mainly of rest and quiet and hospital beds will be needed for more urgent cases. There are several phases in the illness, and the nature, and scope of the provision which will have to be made will depend to some extent on the time which has elapsed since the radiation dose was received. The vomiting and diarrhoea are distressing and unpleasant, and it may be desirable to set aside special centres for treating cases of the sickness. Nursing could be on a rota system, shared by members of the Welfare Section and others willing and able to help.

* Z Zones are defined as areas above 10 R/hr (10 cGy/hr) of gamma at 48 hrs after burst.

WELFARE IN BILLETS

Main headings

1 Immediate and long term welfare; visiting and supervision of billets; problems of shared homes; unaccompanied children; special groups.

Immediate welfare

2 Initial billeting would have to be carried out at speed and under great pressure. Immediate welfare would consist simply of seeing that evacuees had a roof over their heads and enough food for their needs.

Long term welfare

3 This is an entirely different problem. If a heavy attack on this country followed closely on evacuation, the life-saving aspect of the scheme would be appreciated; people would be ready to accept the extreme discomfort involved and would realise that only help with major difficulties would be possible. If, however, there were no immediate attack, or if a large part of the country were unaffected, many individual difficulties would be brought forward which in an extreme crisis might have been accepted. The Welfare Section will have a large part to play in helping to solve these individual problems which cannot be ignored since to do so would lead to a wide-spread lowering of morale. It must be remembered also that the need for billeting will continue for a long time after the acute phase of hostilities. Training should prepare the volunteer for the more detailed aspect of long-term welfare; some of the service for which training is given may not be needed or may not be practicable, but it is better to train to the ideal and to get as near to it in practice as circumstances permit.

Visiting and supervision of billets

4 (*a*) The amount of visiting will depend on conditions existing at the time and the number of suitable staff available. The initial introduction of evacuee to householder should if possible be made by a responsible person. Doorstep altercations may be avoided if both sides feel that the situation is being handled by some one in authority.

(*b*) Billeting visitors would form a link between the household and the billeting office. Very large numbers of billeting assistants and visitors will be needed if they are to keep in touch with households. There will be a need for tact and complete impartiality, as well as a detailed knowledge of the help available.

(*c*) Billets should be visited within a few days of the initial billeting in order to advise on major difficulties which may have arisen. Further visits would depend on circumstances. If the household is settling down reasonably well, it would be better not to visit too often, but both householder and evacuee must know where to go if help is needed.

(*d*) In billets where there are unaccompanied children regular visits should be made. Frequent visits should be made in the early stages; later, if all seems well, once a month might be sufficient. Children who were in the care of the local authority (i.e., under the Children Act, 1948 or the Children and Young Persons' Act, 1933) at the time of evacuation, would come under the supervision of the Children's Officer in the reception area; other unaccompanied children would be supervised by the staff of the billeting officer.

Problems of shared homes

5 (*a*) Sharing a home is never easy even when the families are known to each other and sharing is by mutual agreement. Sharing under conditions resulting from evacuation will be infinitely more difficult.

(*b*) As far as possible householder and evacuee should work out their own plan for sharing, but the billeting visitor should be ready to discuss plans and to advise if asked to do so. Both evacuee and householder should appreciate the other's point of view; preparatory work in this connection might be possible.

(*c*) Common difficulties arising from shared homes:

- (i) responsibility for shared kitchens and bathrooms; timing of meals, etc.;
- (ii) apportionment of cost of light and fuel;
- (iii) responsibility for cleaning passages, stairs, etc.;
- (iv) use of cleaning materials and cooking utensils.

(*d*) The social standards and customs of evacuees and householder may be entirely different. The easiest solution would be for families to live completely independently but the size of the house and the available rooms might make this impracticable.

Needs of special groups

Unaccompanied children

6 (*a*) Special arrangements will be made for certain groups of unaccompanied children, i.e. (1) nursery and nursery school children (2) children attending special schools (e.g., for the handicapped). These groups will be accompanied by their own staff and will go to pre-arranged accommodation in the reception areas; it is unlikely that Welfare Section members will be called upon to help.

(*b*) Those children whose relatives cannot accompany them will be collected together in parties, sent to reception areas and billeted in private houses. The choice of billets for unaccompanied children should receive special care;

- (i) they should only be billeted on persons willing to accept them;
- (ii) if possible they should be billeted on persons accustomed to the care of children;
- (iii) the billet must be visited regularly to ensure that the children are being well cared for. The billeting visitor should establish friendly relations with the householder so that visits are not looked upon as an intrusion but as an opportunity for friendly discussion.

(*N.B. See earlier reference to children in care of the local authority.*)

(*c*) Even householders accustomed to children may not be prepared for problems which may arise when a child is separated from his family. Such problems are likely to be more acute when separation is the result of hurried evacuation without an opportunity for mental preparation. The child's insecurity may show itself in:

- (i) bed-wetting;
- (ii) problems of behaviour—extreme aggressiveness or timidity, temper tantrums, pilfering.

Kindness and commonsense handling will usually enable the difficulties to be overcome, but the billeting visitor must be able to advise the householder and must know what practical help is available. Cases of real difficulty should be reported to the billeting officer.

7 In addition to unaccompanied children there will be other groups whose welfare will need special consideration:

(a) Expectant mothers

Special arrangements will be made for those within one month of their expected date of confinement; others will be billeted in the ordinary way but may move to special lying-in accommodation later, if such accommodation should be available.

The address of expectant mothers' billets should be notified to the Medical Officer of Health so that Health Visitors may visit and advise. On leaving hospital, mother and baby will be re-billeted. It would be an obvious advantage if they could return to her former billet. Special arrangements may have to be made for the care of other children in the family while their mother is in hospital.

(b) Aged-infirm, blind persons and cripples

If the degree of infirmity or handicap is not too great, these will be billeted in private households. Many aged and handicapped will be accompanied by members of their family who will be responsible for their general welfare. Those who are unaccompanied may need specially selected billets:

(i) With householders who are prepared to give the extra care necessary.

(ii) In houses suitable for the particular disability, e.g., few stairs, indoor sanitation, etc.

The local authority's welfare officer and/or any appropriate voluntary organisation in the neighbourhood should be put in touch.

(c) Adolescents

A new priority class in the revised evacuation scheme. In general, adolescents will be part of family units and may be billeted with that family. They may need suitable work and this will be dealt with by the local office of the Ministry of Labour and National Service. Where possible, organised activity for out-of-work hours should be arranged. Social clubs and organisations should be asked to extend their facilities to evacuated young people. Billeting visitors should know what is available.

Notes on teaching WE 10

8 Volunteers who are likely to be called upon to act as billeting visitors should take advantage of any opportunity of any activity which brings them in contact with all types of people, e.g., helping with clubs, outings, welfare clinics, etc. and so gain experience in social work.

9 The instructor should make it clear that the priority classes mentioned in his talk are those of the provisional evacuation scheme.

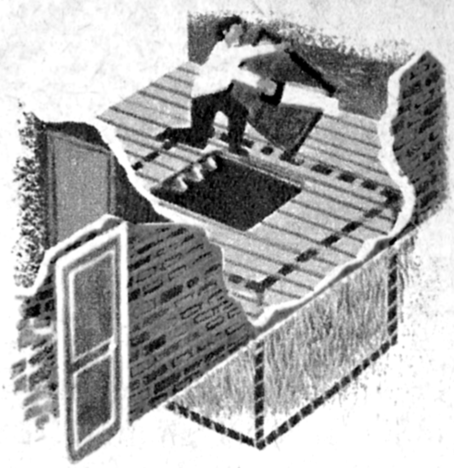
10 Volunteers should make themselves familiar with the peace-time welfare services in their neighbourhood, both statutory and voluntary, but must realise that many, if not all, of these services might be disrupted by war.

11 In dealing with human problems the personality of the individual concerned plays a very large part in deciding how a situation may best be handled. Any approach must be extremely flexible and capable of being adapted to meet the circumstances.

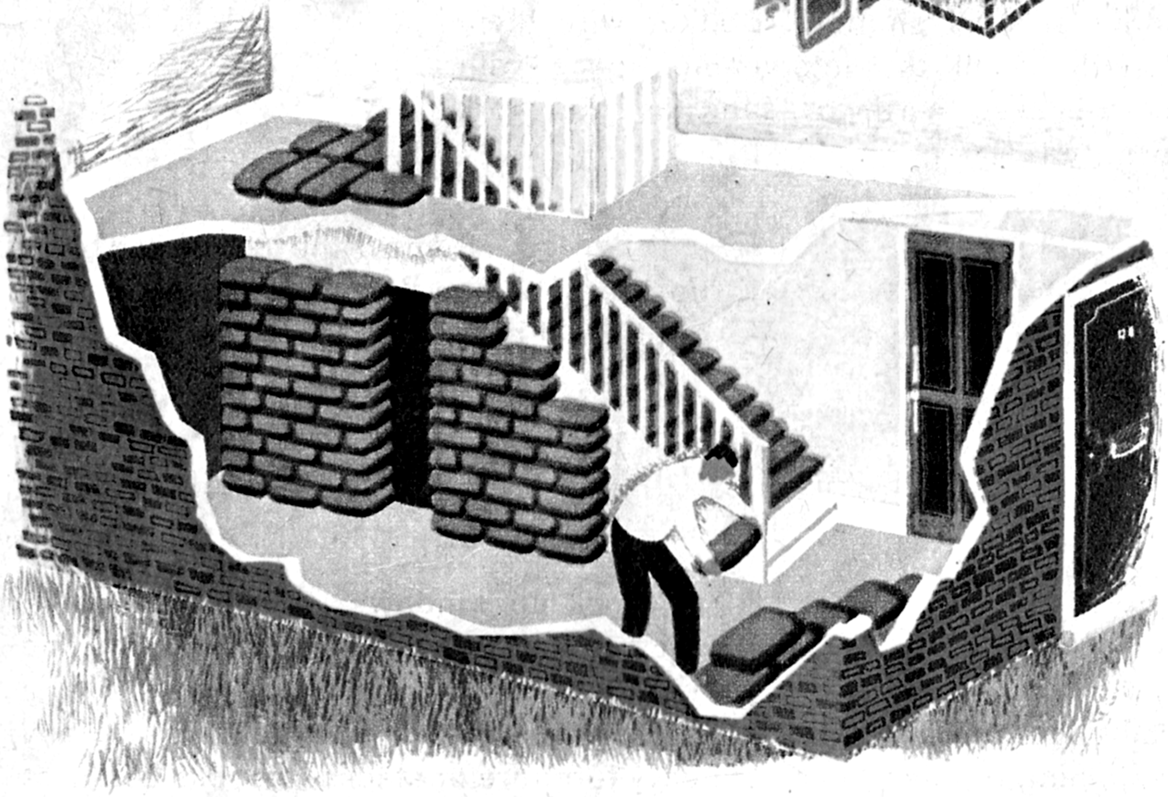
Environmental Radiation Protection Factors
Provided by Civilian Vehicles

Vehicle	Position	Protection Factor Range
Commercial bus (common type)	Throughout bus	1.5-2.0
Commercial bus (scenic cruiser type)	Throughout bus	1.5-2.0
School bus	Throughout bus	1.5-1.8
Passenger car	Passenger side (chest)	1.5-1.7
	Driver side	1.5-1.7
Pickup	Driver side	1.9-2.1
Crew cab	Driver side	1.8-2.0
	Back seat	1.8-2.0
Carryall	Driver side	1.7-1.9
	Rear side	1.7-1.9
2-1/2-ton truck	Driver side	1.8-2.0
	Center of bed	1.4-1.6
5-ton truck	Driver side	2.0-2.2
	Sleeper	1.9-2.1
Heavy Truck	Driver side	1.4-1.6
	Center of trailer	2.7-3.1
Fire truck	Driver side	2.7-3.1
	Standing area in back	1.6-1.8
Switch engine	Engineer's seat	3.0-3.5
Railway guard car	Sleeping quarters	2.2-2.6
	Kitchen area	2.4-2.8
	Center area	2.0-2.4
Heavy locomotive	Engineer's seat	3.0-3.5

SOURCE: Z. G. Burson, "Environmental and Fallout Gamma Radiation Protection Factors Provided by Civilian Vehicles," Health Physics, 26, 41-44, 1974.

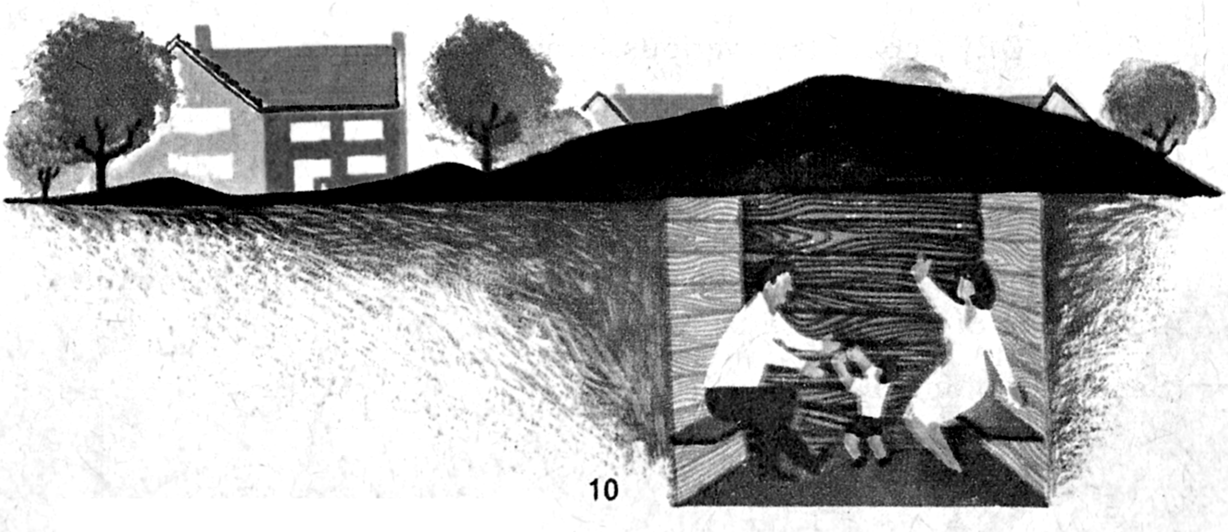


SHELTER "CORES"



Outdoor Fall-out Shelter

If it is impossible for you to prepare an indoor fall-out shelter, a trench dug outside your home would provide good protection. It should be deep enough to provide comfortable standing room and the sides should be shored up. After placing supports across the trench, cover the top with boards, metal sheets or concrete slabs, and heap earth on top. Leave a manhole-type entrance with a movable cover such as a dustbin lid. Keep a small ladder or a pair of household steps there.



UK CD Handbook 10, Advising the Householder, January 1963

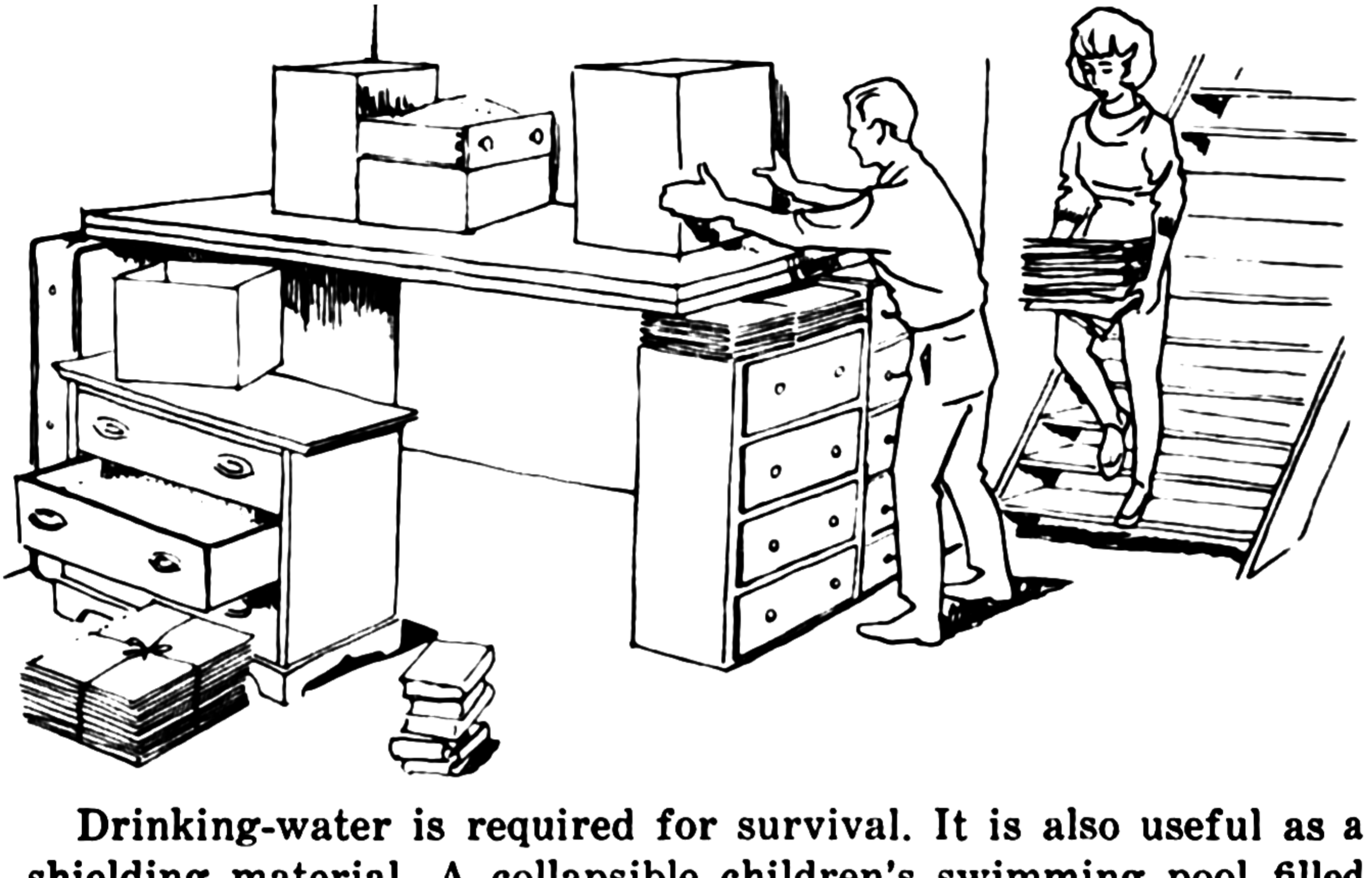
PERSONAL AND FAMILY SURVIVAL

SM-3-11

"...the history of this planet and particularly the history of the 20th Century is sufficient to remind us of the possibilities of an irrational attack, a miscalculation, and accidental war, or a war of escalation in which the stakes by each side gradually increase to the point of maximum danger which cannot be either foreseen or deterred. It is on this basis that civil defense can be readily justified—as insurance for the civilian population in case of enemy miscalculation. It is insurance we trust will never be needed—but insurance which we would never forgive ourselves for foregoing in the event of catastrophe."

— President Kennedy, in May 1961

Remove doors from their hinges and place them over supports



Drinking-water is required for survival. It is also useful as a shielding material. A collapsible children's swimming pool filled with water and located over the best corner of your basement will help improve the fallout protection. A bathtub, if suitably located, can also be used for this purpose.

DEPARTMENT OF DEFENSE
OFFICE OF CIVIL DEFENSE

Foreword

If the country were ever faced with an immediate threat of nuclear war, a copy of this booklet would be distributed to every household as part of a public information campaign which would include announcements on television and radio and in the press. The booklet has been designed for free and general distribution in that event. It is being placed on sale now for those who wish to know what they would be advised to do at such a time.

May 1980

Protect and Survive
ISBN 0 11 3407289

If Britain is attacked by nuclear bombs or by missiles, we do not know what targets will be chosen or how severe the assault will be.

If nuclear weapons are used on a large scale, those of us living in the country areas might be exposed to as great a risk as those in the towns. The radioactive dust, falling where the wind blows it, will bring the most widespread dangers of all. No part of the United Kingdom can be considered safe from both the direct effects of the weapons and the resultant fall-out.

The dangers which you and your family will face in this situation can be reduced if you do as this booklet describes.

Planning for survival

Stay at Home

Your own local authority will best be able to help you in war.
If you move away – unless you have a place of your own to go to or intend to live with relatives – the authority in your new area will not help you with accommodation or food or other essentials.
If you leave, your local authority may need to take your empty house for others to use.
So stay at home.

Plan a Fall-out Room and Inner Refuge

The first priority is to provide shelter within your home against radioactive fall-out. Your best protection is to make a fall-out room and build an inner refuge within it.

First, the Fall-out room

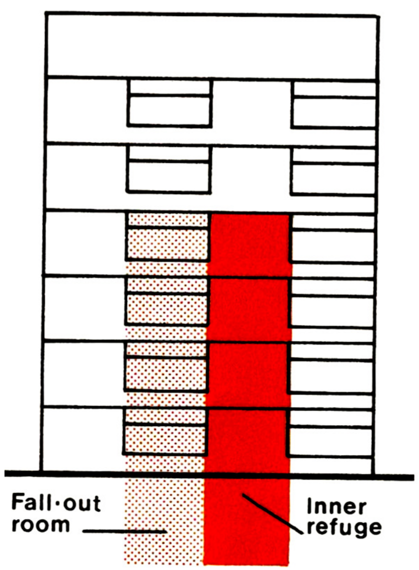
Because of the threat of radiation you and your family may need to live in this room for fourteen days after an attack, almost without leaving it at all. So you must make it as safe as you can, and equip it for your survival. Choose the place furthest from the outside walls and from the roof, or which has the smallest amount of outside wall. The further you can get, within your home, from the radioactive dust that is on or around it, the safer you will be. Use the cellar or basement if there is one. Otherwise use a room, hall or passage on the ground floor.

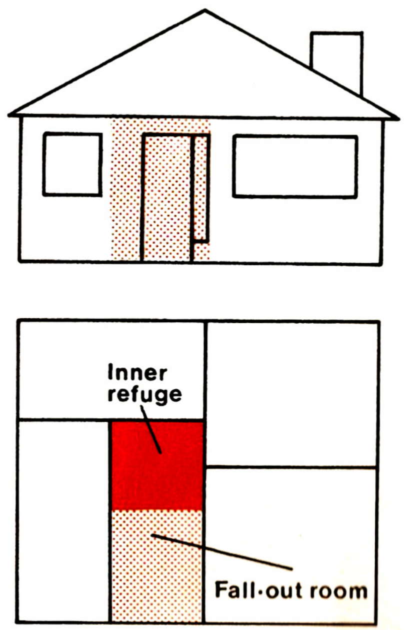
Now the Inner Refuge

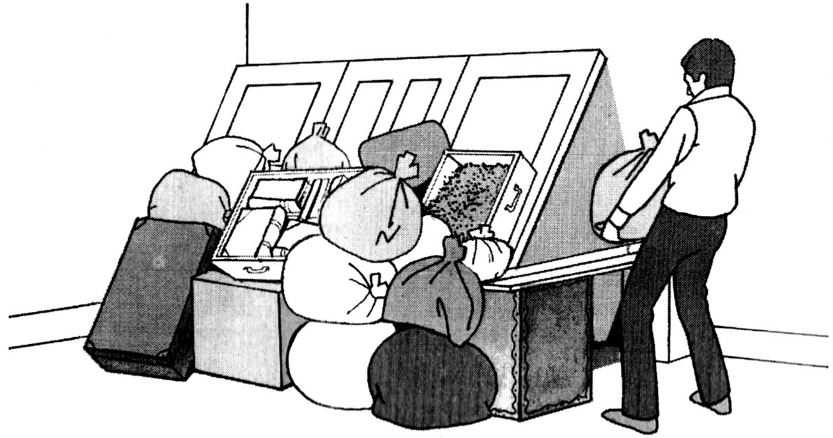
Still greater protection is necessary in the fall-out room, particularly for the first two days and nights after an attack, when the radiation dangers could be critical. To provide this you should build an inner refuge. This too should be thick-lined with dense materials to resist the radiation, and should be built away from the outside walls.

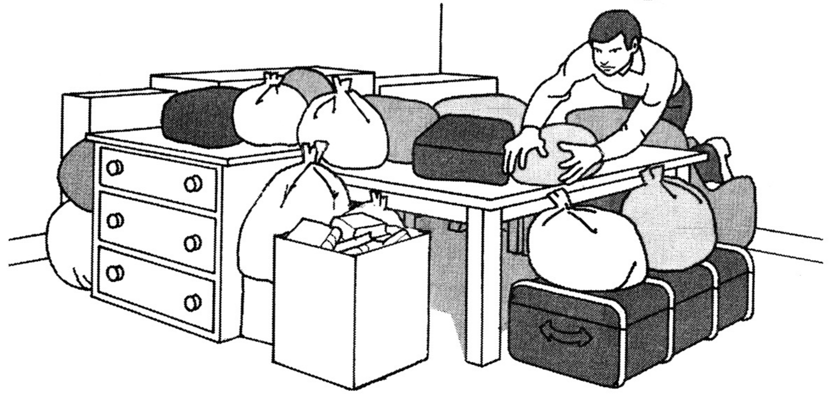
Here are some ideas:

Make a 'lean-to' with sloping doors taken from rooms above or strong boards rested against an inner wall. Prevent them from slipping by fixing a length of wood along the floor. Build further protection of bags or boxes of earth or sand – or books, or even clothing – on the slope of your refuge, and anchor these also against slipping. Partly close the two open ends with boxes of earth or sand, or heavy furniture.

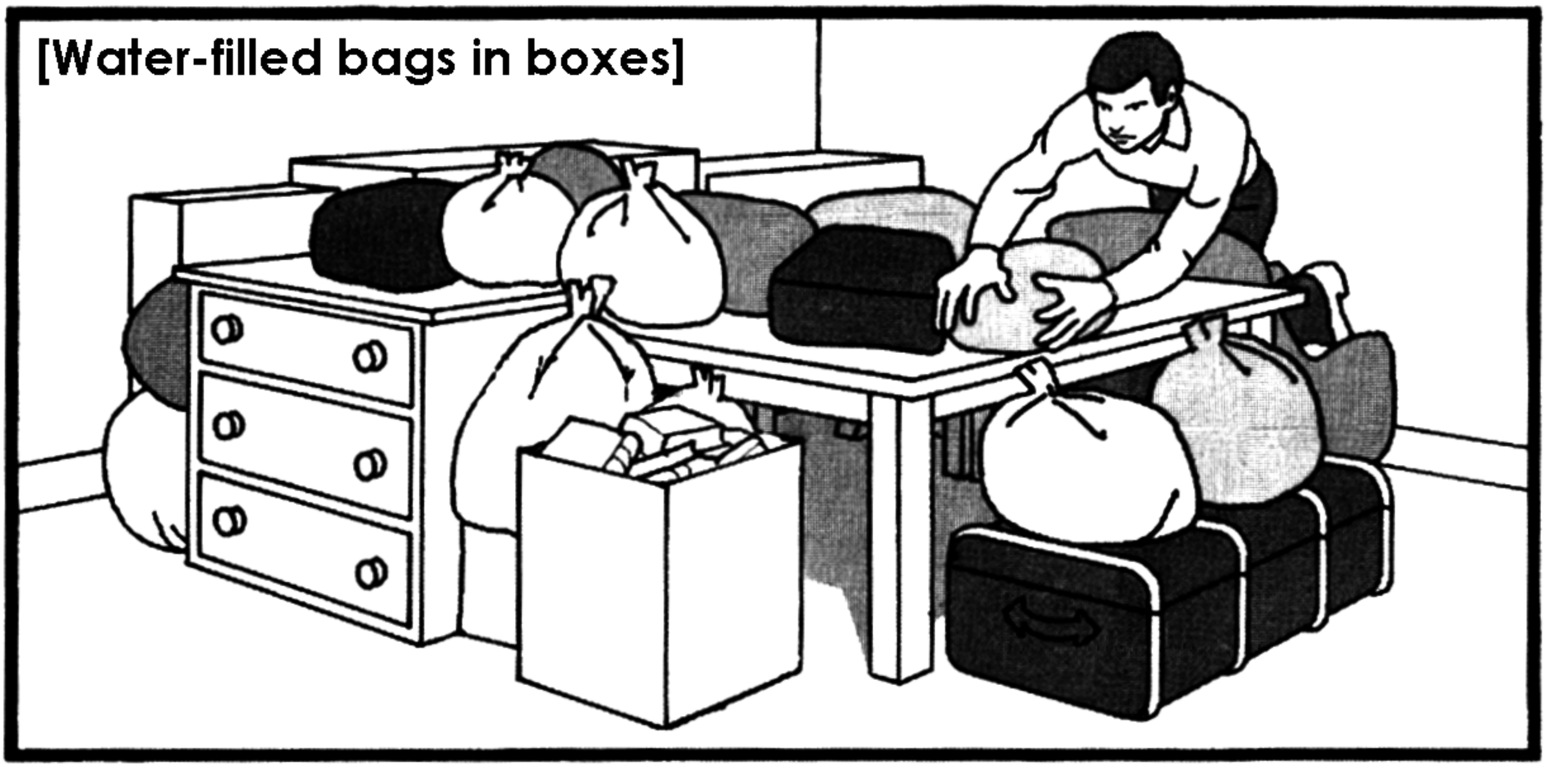






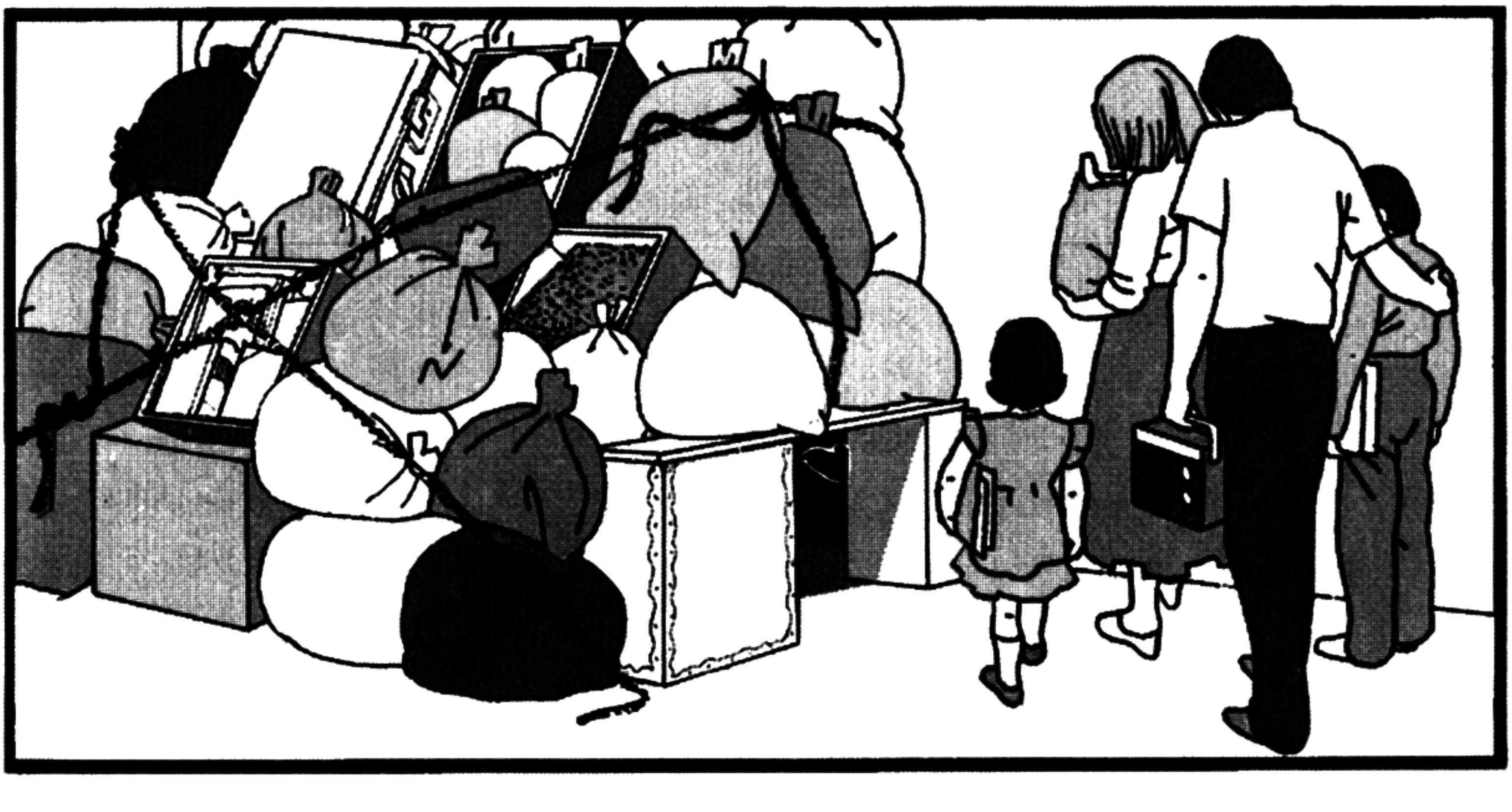


Protect and Survive
UK Government, May 1980



If there is structural damage from the attack you may have some time before a fall-out warning to do minor jobs to keep out the weather – using curtains or sheets to cover broken windows or holes.

If you are out of doors, take the nearest and best available cover as quickly as possible, wiping all the dust you can from your skin and clothing at the entrance to the building in which you shelter.



Proceedings of the Symposium
held at Washington, D. C.
April 19-23, 1965 by the
Subcommittee on Protective Structures,
Advisory Committee on Civil Defense,
National Academy of Sciences—
National Research Council

Protective Structures for CIVILIAN POPULATIONS

1966

THE PROTECTION AGAINST FALLOUT RADIATION AFFORDED BY CORE SHELTERS IN A TYPICAL BRITISH HOUSE

Daniel T. Jones
Scientific Adviser, Home Office, London

Protective Factors in a Sample of British Houses (Windows Blocked)

Protective Factor	Percentage of Houses
< 25	36%
25-39	28%
40-100	29%
> 100	7%

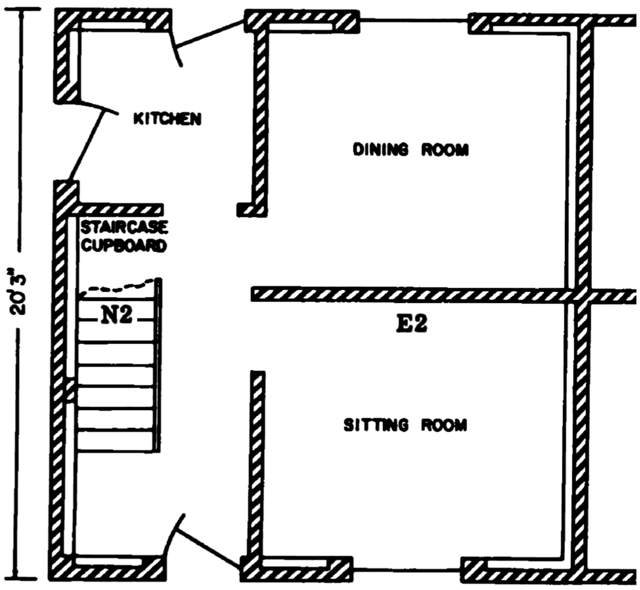
"A very much improved protection could be obtained by constructing a shelter core. This means a small, thick-walled shelter built preferably inside the fallout room itself, in which to spend the first critical hours when the radiation from fallout would be most dangerous."(1)

The full-scale experiments were carried out at the Civil Defense School at Falfield Park.(2)

In the staircase construction, the shelter consisted of the cupboard under the stairs, sandbags being placed on treads above and at the sides.

A 93 curies cobalt-60 source was used.

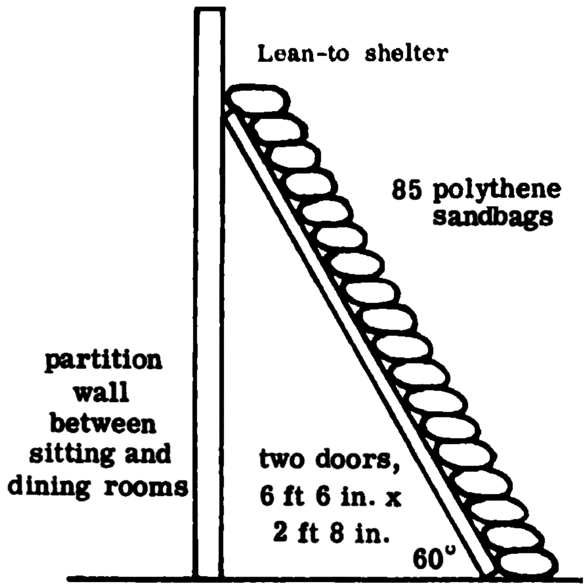
1. Six sandbags per tread, and a double layer on the small top landing. 96 sandbags were used.
2. As (1), together with a 4-ft-high wall of sandbags along the external north wall. 160 sandbags were used.
3. As (2), together with 4-ft-high walls of sandbags along the kitchen/cupboard partition wall and along the passage partition. 220 sandbags were used.



9 in. brick walls The windows and doors were not blocked	Position	contribution r/hr/c/ft^2 Ground	Roof	Protective Factor
House only	E2	15.0	8.4	21
Lean-to	E2	10.4	2.4	39
Staircase cupboard:				
Stairs only sandbagged	N2	29.2	5.3	14
Stairs and outer wall sandbagged	N2	16.4	4.6	24
Stairs, outer wall, kitchen wall and corridor partition sandbagged	N2	8.8	1.8	47

1. Civil Defence Handbook No. 10, HMSO, 1963.
2. Perryman, A. D., Home Office Report CD/SA 117.

sandbags 24 in. x 12 in. when empty; 16 in. x 9 in. x 4 in. when filled with 25 lb of sand.



floor area 21 sq ft.

MODEL ANALYSIS

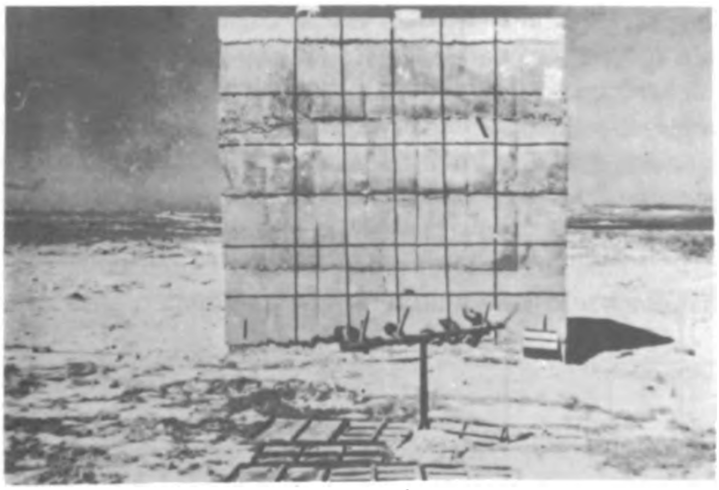
Mr. Ivor Ll. DAVIES
Suffield Experimental Station
Canadian Defense Research Board
Ralston, Alberta, Canada

Nuclear-Weapon Tests

In 1952 we fired our first nuclear device, effectively a "nominal" weapon, at Monte Bello, off northwest Australia. To the blast loading from this weapon we exposed a number of reinforced-concrete cubicle structures that had been designed for the dynamic loading conditions, and for which we made the best analysis of response we were competent to make at that time. Our estimates of effects were really a dismal failure. The structures were placed at pressure levels of 30, 10, and 6 psi, where we expected them to be destroyed, heavily damaged with some petaling of the front face, and extensively cracked, respectively. In fact, the front face of the cubicle at 30 psi was broken inwards; failure had occurred along both diagonals, and the four triangular petals had been pushed in. At the 10-psi level, where we had three cubicles, each with a different wall thickness (6, 9, and 12 in.), we observed only light cracking in the front face of that cubicle with the least thick wall (6 in.). The other two structures were apparently undamaged, as was the single structure at the 6-psi level.

In 1957, the first proposals were made for the construction of the underground car park in Hyde Park in London. The Home Office was interested in this project since, in an emergency, the structure could be used as a shelter. Consequently a request was made to us at Atomic Weapons Research Establishment (A.W.R.E.) to design a structure that would be resistant to a blast loading of about 50 psi, and to test our design on the model scale.

Using the various load-deformation curves obtained in this test, an estimate was made of the response of the structure to blast loading. Of particular interest was the possible effect of 100 tons of TNT, the first 100-ton trial at Suffield in Alberta.



10 p.s.i.

34 p.s.i.

Dynamic tests, Monte Bello cubicles.

A total of seven more models was made; six were shipped to Canada and placed with the top surface of the roof flush with the ground and at positions where peak pressures of 100, 80, 70, 60, 50, and 40 psi were expected. The seventh model was kept in England for static testing at about the time of firing. The results were not as expected. In the field, the four models farthest from the charge were apparently undamaged; we could see no cracking with the eye, nor did soaking the models with water reveal more than a few hair cracks. The model nearest the charge was lightly cracked in the roof panels and beams, and one of the columns showed slight spalling at the head. This model had been exposed to a peak pressure of 110 psi.

BLAST AND OTHER THREATS

Harold Brode
The RAND Corporation, Santa Monica, California

Chemical High-Explosive Weapons

As in past aerial warfare, bombs and missiles carrying chemical explosives to targets are capable of extensive damage only when delivered in large numbers and with high accuracy.

Biological Warfare

Most biological agents are inexpensive to produce; their effective dissemination over hostile territories remains the chief deterrent to their effective employment. Twenty square miles is about the area that can be effectively covered by a single aircraft; large area coverage presents a task for vast fleets of fairly vulnerable planes flying tight patterns at modest or low altitudes. While agents vary in virulence and in their biologic decay rate, most are quite perishable in normal open-air environments. Since shelter and simple prophylactic measures can be quite effective against biological agents, there is less likelihood of the use of biological warfare on a wholesale basis against a nation, and more chance of limited employment on population concentrations —perhaps by covert delivery, since shelters with adequate filtering could insure rather complete protection to those inside.

Chemical Weapons

Chemical weapons, like biological weapons, are relatively inexpensive to create, but face nearly insurmountable logistics problems on delivery. Although chemical agents produce casualties more rapidly, the greater amounts of material to deliver seriously limit the likelihood of their large-scale deployment. Furthermore, chemical research does not hold promise of the development of significantly more toxic chemicals for future use.

Radiological Weapons

The advantages of such modifications are much less real than apparent. In all weapons delivered by missiles, minimizing the payload and total weight is very important. If the total payload is not to be increased, then the inclusion of inert material to be activated by neutrons must lead to reductions in the explosive yield. If all the weight is devoted to nuclear explosives, then more fission-fragment activity can be created, and it is the net difference in activity that must be balanced against the loss of explosive yield. As it turns out, a fission explosion is a most efficient generator of activity, and greater total doses are not achieved by injecting special inert materials to be activated.

Perret, W.R., Ground Motion Studies at High Incident Overpressure, The Sandia Corporation, Operation PLUMBBOB, WT-1405, for Defense Atomic Support Agency Field Command, June 1960.

The Neutron Bomb

The neutron bomb, so called because of the deliberate effort to maximize the effectiveness of the neutrons, would necessarily be limited to rather small yields—yields at which the neutron absorption in air does not reduce the doses to a point at which blast and thermal effects are dominant. The use of small yields against large-area targets again runs into the delivery problems faced by chemical agents and explosives, and larger yields in fewer packages pose a less stringent problem for delivery systems in most applications. In the unlikely event that an enemy desired to minimize blast and thermal damage and to create little local fallout but still kill the populace, it would be necessary to use large numbers of carefully placed neutron-producing weapons burst high enough to avoid blast damage on the ground, but low enough to get the neutrons down. In this case, however, adequate radiation shielding for the people would leave the city unscathed and demonstrate the attack to be futile.

The thermal radiation from a surface burst is expected to be less than half of that from an air burst, both because the radiating fireball surface is truncated and because the hot interior is partially quenched by the megatons of injected crater material.

SUPERSEISMIC GROUND-SHOCK MAXIMA (AT 5-FT DEPTH)

Vertical acceleration: $\alpha_{vm} \simeq 340\,\Delta P_s/C_L$ ± 30 per cent. Here acceleration is measured in g's and overpressure (ΔP_s) in pounds per square inch. An empirical refinement requires C_L to be defined as the seismic velocity (in feet per second) for rock, but as three fourths of the seismic velocity for soil.

OUTRUNNING GROUND-SHOCK MAXIMA (AT ~10-FT DEPTH)

Vertical acceleration: $\alpha_{vm} \simeq 2 \times 10^5/C_L r^2$ + factor 4 or -factor 2. Acceleration is measured in g's, and r is the scaled radial distance—i.e., $r = R/W^{1/3}$ kft/(mt)$^{1/3}$.

Data taken on a low air-burst shot in Nevada indicate an exponential decay of maximum displacement with depth. For the particular case of a burst of ~ 40 kt at 700 ft, some measurements were made as deep as 200 ft below the surface of Frenchman Flat, a dry lake bed, which led to the following approximate decay law, according to Perret.

$\delta = \delta_0 \exp(-0.017D)$,

where δ represents the maximum vertical displacement induced at depth D, δ_0 is the maximum displacement at the surface, and D is the depth in feet.

18th April, 1950.

Sir,

Civil Defence Act, 1948
Regulations relating to the Evacuation of the
Civil Population (Statutory Instrument 1949, No.2147)

1. I am directed to refer to Circular 81/49 (Wales) of 23rd August, 1949, which transmitted for your information a copy of the draft Civil Defence (Evacuation and Care of the Homeless) Regulations, 1949. These Regulations have now been approved by both Houses of Parliament and are now operative. I am now to enclose a copy of a Memorandum on Evacuation (Memo Ev.1 (1950) which contains an outline of the general plan for the transfer of certain sections of the civilian population from the more densely populated areas in the event of war or the imminence of war. For the purpose of this transfer the system developed in the 1939/45 war has been adopted, whereby the country is divided into evacuation, neutral and reception areas

9. **ESTIMATES OF ACCOMMODATION IN RECEPTION AREAS**

In order that specific allocations may be worked out and each Reception Authority informed of the number of members of the priority classes for whom their plans should provide, it is requested that every Reception Authority will prepare an estimate of the total number of habitable rooms in their area. The Minister of Health has been advised by the Associations of Local Authorities that the Receptio Authorities (who are the Housing Authorities) will be able to make reasonably accurat estimates from information already available to them. The estimate should include all rooms normally used in the locality either as living rooms or as bedrooms. I am to ask that this estimate may be forwarded to the Department, not later than 30th June, 1950.

10. The Department do not consider that any useful purpose would be served by carrying out at this stage a detailed survey of the accommodation which could be made available for evacuees such as was undertaken in January, 1939.

IV. LATER ACTION

11. When the specific allocations of the number of members of the priority classes for whose reception arrangements should be made in each reception area have been decided, it will be possible to link each Reception Authority with a particular Evacuation Authority. When the plan has been developed in this way, or as the

---

14. The Memorandum on Evacuation (Memo Ev.1 (1950) has been placed on sale. Further copies may be purchased direct from His Majesty's Stationery Office or from any bookseller.

I am, Sir,
Your obedient Servant,

William Thomas

The Clerk of the Council.

Appendix for Group

LINKING OF EVACUATION AND RECEPTION AREAS
FOR ORGANISED EVACUATION

MERSEYSIDE GROUP

EVACUATION AREAS

Liverpool C.B.	Bebington B.
Birkenhead C.B.	Widnes B.
Wallasey C.B.	Litherland U.D.
Bootle C.B.	Northwich U.D.
Crosby B.	Runcorn U.D.
	Ellesmere Port U.D.

Estimated Civil Population, 1,320,000 *

Estimated number of members of priority classes, 376,300

ASSOCIATED RECEPTION AREAS

County	Local Authority		Estimated Civil Population *
Cheshire	Chester C.B.		48,000
	Alsager U.D.		5,000
	Hoole U.D.		9,000
	Hoylake U.D.		26,000
	Middlewich U.D.		6,000
	Nantwich U.D.		9,000
	Neston U.D.		9,000
	Sandbach U.D.		9,000
	Winsford U.D.		12,000
	Wirral U.D.		17,000
	Chester R.D.		19,000
	Nantwich R.D.		26,000
	Tarvin R.D.		15,000
		Total	210,000
Lancashire	Blackpool C.B.		152,000
	Southport C.B.		84,000
	Colne B.		20,000
	Fleetwood B.		26,000
	Nelson B.		34,000
	Adlington U.D.		4,000
	Barrowford U.D.		5,000
	Brierfield U.D.		7,000
	Formby U.D.		9,000
	Kirkham U.D.		4,000
	Ormskirk U.D.		21,000
	Padiham U.D.		10,000
	Poulton le Fylde U.D.		8,000
	Preesall U.D.		2,000
	Skelmersdale U.D.		6,000

* Registrar-General's estimate of civil population as at mid-1948.

DS 25404/1(17)

ASSOCIATED RECEPTION AREAS (Contd.)

County	Local Authority		Estimated Civil Population *
Cardigan	Aberystwyth B.		10,000
	Cardigan B.		3,000
	Lampeter B.		2,000
	Aberayron U.D.		1,000
	New Quay U.D.		1,000
	Aberayron R.D.		9,000
	Aberystwyth R.D.		10,000
	Teifiside R.D.		10,000
	Tregaron R.D.		5,000
		Total	51,000
Denbigh	Colwyn Bay B.		23,000
	Denbigh B.		8,000
	Ruthin B.		4,000
	Wrexham B.		29,000
	Abergele U.D.		7,000
	Llangollen U.D.		3,000
	Llanrwst U.D.		3,000
	Aled R.D.		7,000
	Ceiriog R.D.		7,000
	Hiraethog R.D.		5,000
	Ruthin R.D.		10,000
	Wrexham R.D.		62,000
		Total	168,000
Flint	Flint B.		14,000
	Buckley U.D.		8,000
	Connah's Quay U.D.		7,000
	Holywell U.D.		8,000
	Mold U.D.		6,000
	Prestatyn U.D.		8,000
	Rhyl R.D.		19,000
	Hawarden R.D.		32,000
	Holywell R.D.		22,000
	Overton R.D.		6,000
	St. Asaph R.D.		8,000
		Total	138,000
Merioneth	Bala U.D.		1,000
	Barmouth U.D.		2,000
	Dolgelley U.D.		2,000
	Festiniog U.D.		7,000
	Towyn U.D.		3,000
	Deudraeth R.D.		7,000
	Dolgelley R.D.		8,000
	Edeyrnion R.D.		4,000
	Penllyn R.D.		3,000
		Total	37,000

1939 British Government Evacuation Leaflet.

PUBLIC INFORMATION LEAFLET NO. 3

Read this and keep it carefully. **You may need it.**

1.5 million people were evacuated by train from cities. Another 2 million privately evacuated cities.

British Government evacuation plans began in 1931, 8 years before war. 75% of Manchester's children were evacuated, compared to just 15% in Sheffield where civil defence was dismissed as propaganda by Labour council members in charge.

EVACUATION

WHY AND HOW?

WHY EVACUATION?

There are still a number of people who ask " What is the need for all this business about evacuation ? Surely if war comes it would be better for families to stick together and not go breaking up their homes ? "

It is quite easy to understand this feeling, because it is difficult for us in this country to realise what war in these days might mean. If we were involved in war, our big cities might be subjected to determined attacks from the air—at any rate in the early stages—and although our defences are strong and are rapidly growing stronger, some bombers would undoubtedly get through.

We must see to it then that the enemy does not secure his chief objects—the creation of anything like panic, or the crippling dislocation of our civil life.

One of the first measures we can take to prevent this is the removal of the children from the more dangerous areas.

THE GOVERNMENT EVACUATION SCHEME

The Government have accordingly made plans for the removal from what are called " evacuable " areas (see list at the back of this leaflet) to safer places called " reception " areas, of school children, children below school age if accompanied by their mothers or other responsible persons, and expectant mothers and blind persons.

The scheme is entirely a voluntary one, but clearly the children will be much safer and happier away from the big cities where the dangers will be greatest.

There is room in the safer areas for these children ; householders have volunteered to provide it. They have offered homes where the children will be made welcome. The children will have their schoolteachers and other helpers with them and their schooling will be continued.

WHAT YOU HAVE TO DO

Schoolchildren

Schoolchildren would assemble at their schools when told to do so and would travel together with their teachers by train. The transport of some 3,000,000 in all is an enormous undertaking. *It would not be possible to let all parents know in advance the place to which each child is to be sent but they would be notified as soon as the movement is over.*

If you have children of school age, you have probably already heard from the school or the local education authority the necessary details of what you would have to do to get your child or children taken away. *Do not hesitate to register your children under this scheme, particularly if you are living in a crowded area.* Of course it means heartache to be separated from your children, but you can be quite sure that they will be well looked after. That will relieve you of one anxiety at any rate. You cannot wish, if it is possible to evacuate them, to let your children experience the dangers and fears of air attack in crowded cities.

Children under five

Children below school age must be accompanied by their mothers or some other responsible person. Mothers who wish to go away with such children should register with the Local Authority. *Do not delay in making enquiries about this.*

A number of mothers in certain areas have shown reluctance to register. Naturally, they are anxious to stay by their menfolk. Possibly they are thinking that they might as well wait and see; that it may not be so bad after all. *Think this over carefully and think of your child or children in good time.* Once air attacks have begun it might be very difficult to arrange to get away.

Expectant Mothers

Expectant mothers can register at any maternity or child welfare centre. For any further information inquire at your Town Hall.

The Blind

In the case of the Blind, registration to come under the scheme can be secured through the home visitors, or enquiry may be made at the Town Hall.

The invasion of France in 1940 led to evacuation of children on the East and South coasts to Wales, in preparation for invasion defences. Efforts to evacuate kids to Canada ended when 77 were killed when the City of Benares was sunk by submarine U-48 on 18 September 1940.

Northampton Independent 8.9.39.

THEY are here. They have settled down. Northamptonshire's population has increased by 39,000 with the arrival of evacuees from the vulnerable districts of London, writes an "Independent" representative.

Young children showed a brave exterior and declined to succumb to the emotional pangs of homesickness.

Northampton people with prodigious sympathy have recognised and appreciated the inner feelings of these little children and others being ruthlessly torn from their homes through the unknown contingencies of war; torn from their cherished belongings, their parents and relatives.

PRIVATE ARRANGEMENTS

If you have made private arrangements for getting away your children to relatives or friends in the country, or intend to make them, you should remember that while the Government evacuation scheme is in progress ordinary railway and road services will necessarily be drastically reduced and subject to alteration at short notice. Do not, therefore, in an emergency leave your private plans to be carried out at the last moment. It may then be too late.

If you happen to be away on holiday in the country or at the seaside and an emergency arises, do not attempt to take your children back home if you live in an "evacuable" area.

WORK MUST GO ON

The purpose of evacuation is to remove from the crowded and vulnerable centres, if an emergency should arise, those, more particularly the children, whose presence cannot be of any assistance.

Everyone will realise that there can be no question of wholesale clearance. We are not going to win a war by running away.

Most of us will have work to do, and work that matters, because we must maintain the nation's life and the production of munitions and other material essential to our war effort. For most of us therefore, who do not go off into the Fighting Forces our duty will be to stand by our jobs or those new jobs which we may undertake in war.

Some people have asked what they ought to do if they have no such definite work or duty.

You should be very sure before deciding that there is really nothing you can do. There is opportunity for a vast variety of services in civil defence. YOU must judge whether in fact you can or cannot help by remaining. If you are sure you cannot, then there is every reason why you should go away if you can arrange to do so, but you should take care to avoid interfering with the official evacuation plans. If you are proposing to use the public transport services, make your move either BEFORE the evacuation of the children begins or AFTER it has been completed. You will not be allowed to use transport required for the official evacuation scheme and other essential purposes, and you must not try to take accommodation which is required for the children and mothers under the Government scheme.

For the rest, we must remember that it would be essential that the work of the country should go on. Men and women alike will have to stand firm, to maintain our effort for victory. Such measures of protection as are possible are being pushed forward for the large numbers who have to remain at their posts. That they will be ready to do so, no one doubts.

The "evacuable" areas under the Government scheme are:—
(*a*) London, as well as the County Boroughs of West Ham and East Ham; the Boroughs of Walthamstow, Leyton, Ilford and Barking in Essex; the Boroughs of Tottenham, Hornsey, Willesden, Acton, and Edmonton in Middlesex; (*b*) the Medway towns of Chatham, Gillingham and Rochester; (*c*) Portsmouth, Gosport and Southampton; (*d*) Birmingham and Smethwick; (*e*) Liverpool, Bootle, Birkenhead and Wallasey; (*f*) Manchester and Salford; (*g*) Sheffield, Leeds, Bradford and Hull; (*h*) Newcastle and Gateshead; (*i*) Edinburgh, Rosyth, Glasgow, Clydebank and Dundee.

In some of these places only certain areas will be evacuated. Evacuation may be effected from a few other places in addition to the above, of which notice will be given.

Issued from the Lord Privy Seal's Office July, 1939

15 BOYS—BANG GO THE CHAIRS

Herald 28/4/39 P.7

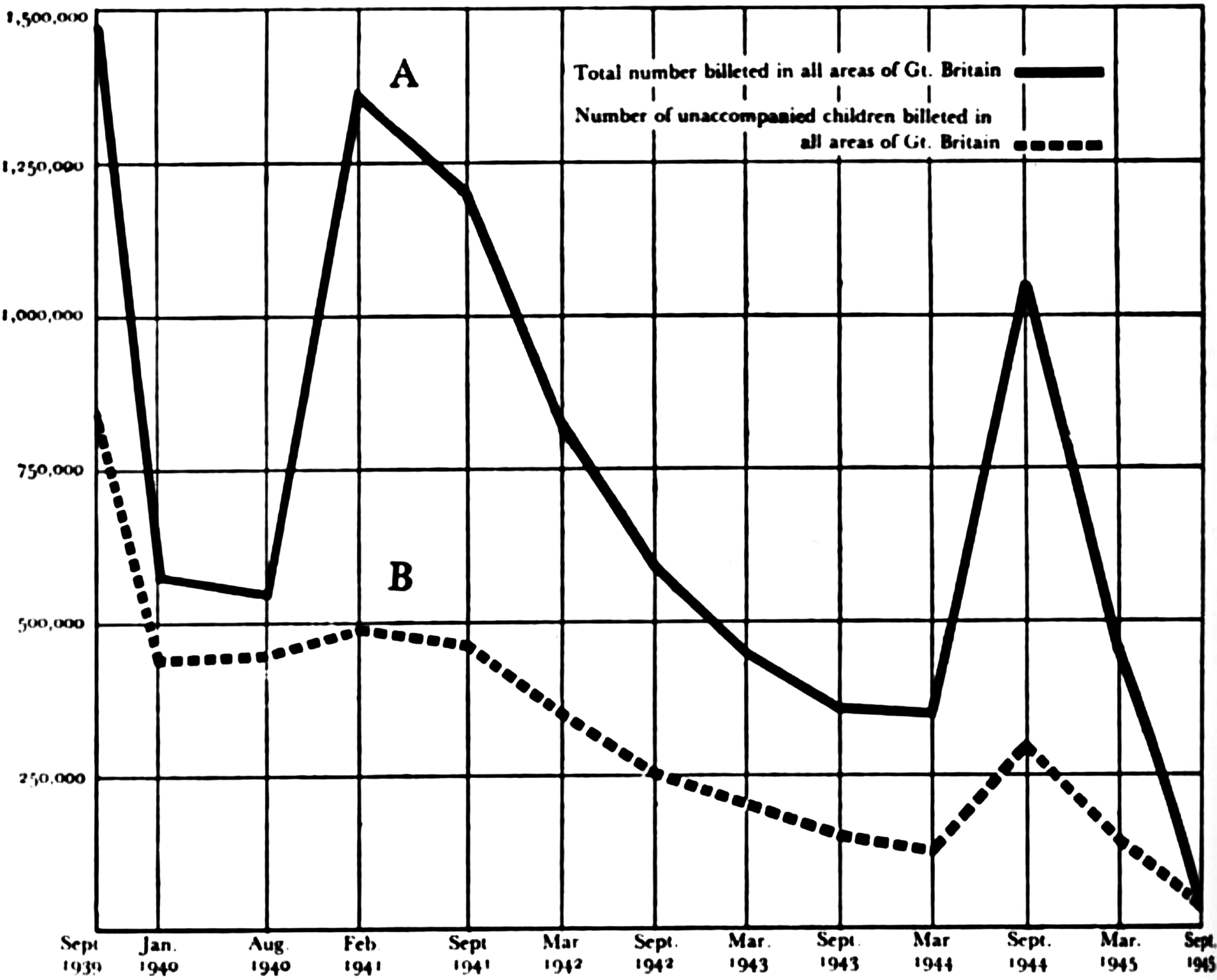
MRS. MAY WELCH, of Beaconsfield Villas, Brighton, has so many children she doesn't know what to do.

But, unlike those of the Old Lady Who Lived in a Shoe, they are not her own. They are evacuees.

She has fifteen—all boys.

"And I can't cope with them," she told the magistrate yesterday when she was summoned for showing a light in the black-out.

"It was one of those boys," she explained. "He took a candle into an empty room."



R. Titmuss, 1950, Problems of Social Policy, page 356: "GOVERNMENT EVACUATION SCHEME 1939–45. The accompanying diagram depicts the important phases in the history of evacuation. Line A represents the total number of persons billeted or otherwise accommodated under Government authority and includes, as well as mothers and children, teachers, helpers, the aged and infirm, homeless people and other assisted groups. Line B picks out only the unaccompanied children."

Use of voluntary services to train civil defence in first aid, etc., prior to WWII:

War Years 39

Under the impact of the emergency there was a rush to acquire first-aid knowledge, which profoundly affected the Association. Certificates issued in 1937 totalled over 48,000. In the peak year of 1940, the number rose to over 298,000.

Class instruction became a major matter. The Government, through air-raid precautions, invited the Association and the Red Cross to train Civil Defence personnel in first-aid and anti-gas measures. . . .

Numerically, the Brigade rose. At the end of 1938 the adult strength was just over 55,000 men and 17,000 women. A year later the figures read: 72,000 men and 31,000 women.

- Joan Clifford, "A Good Uniform: The St John [Ambulance Association] Story", London, 1967

First aid in an underground shelter during World War II.

British Ministry of Health 1939 poster about evacuation: on Friday 1 September 1939, Hitler's Nazis invaded Poland. This IMMEDIATELY triggered Operation Pied Piper, the evacuation of children from cities, PRIOR to Britain declaring war on 3 September 1939!

Where a woman's help is needed

VOLUNTEER FOR THE

Welfare Section

C D

CIVIL DEFENCE CORPS
Ask at your Council Offices


CIVIL DEFENCE
WOMEN WANTED FOR
EVACUATION SERVICE

Effectiveness of Some Civil Defense Actions in Protecting Urban Populations (u)

Appendix B of Defense of the US against Attack by Aircraft and Missiles (u)

ORO-R-17, Appendix B

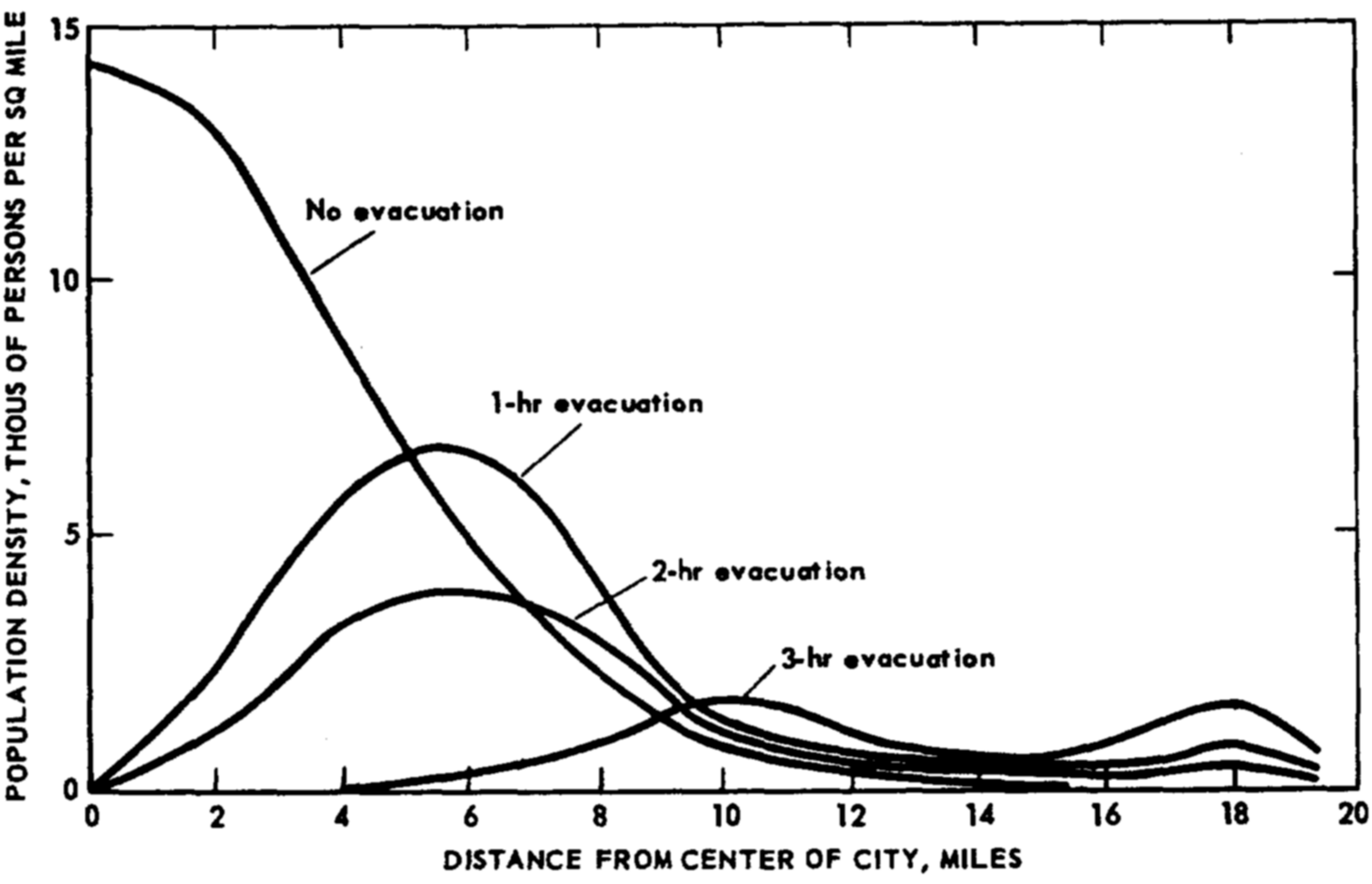


Fig. 10 — Population Density of Washington Target as Function of Distance from Center of City for Three Evacuation Times

THE A.F.S. THE AUXILIARY FIRE SERVICE

A firewoman takes down a message for transmission by 'Walkie-Talkie.'

AUXILIARY FIREWOMEN are trained to do the same jobs as regular firewomen. They learn organisation and administration, the control and mobilising of fire appliances and how to operate V.H.F. radio. They may be drivers or crews of mobile controls or canteen vans.

THE NUMBER OF ATOMIC BOMBS EQUIVALENT TO THE LAST WAR AIR ATTACKS ON GREAT BRITAIN AND GERMANY

UK National Archives HO 225/16, 30 January 1950, Top Secret

Summary

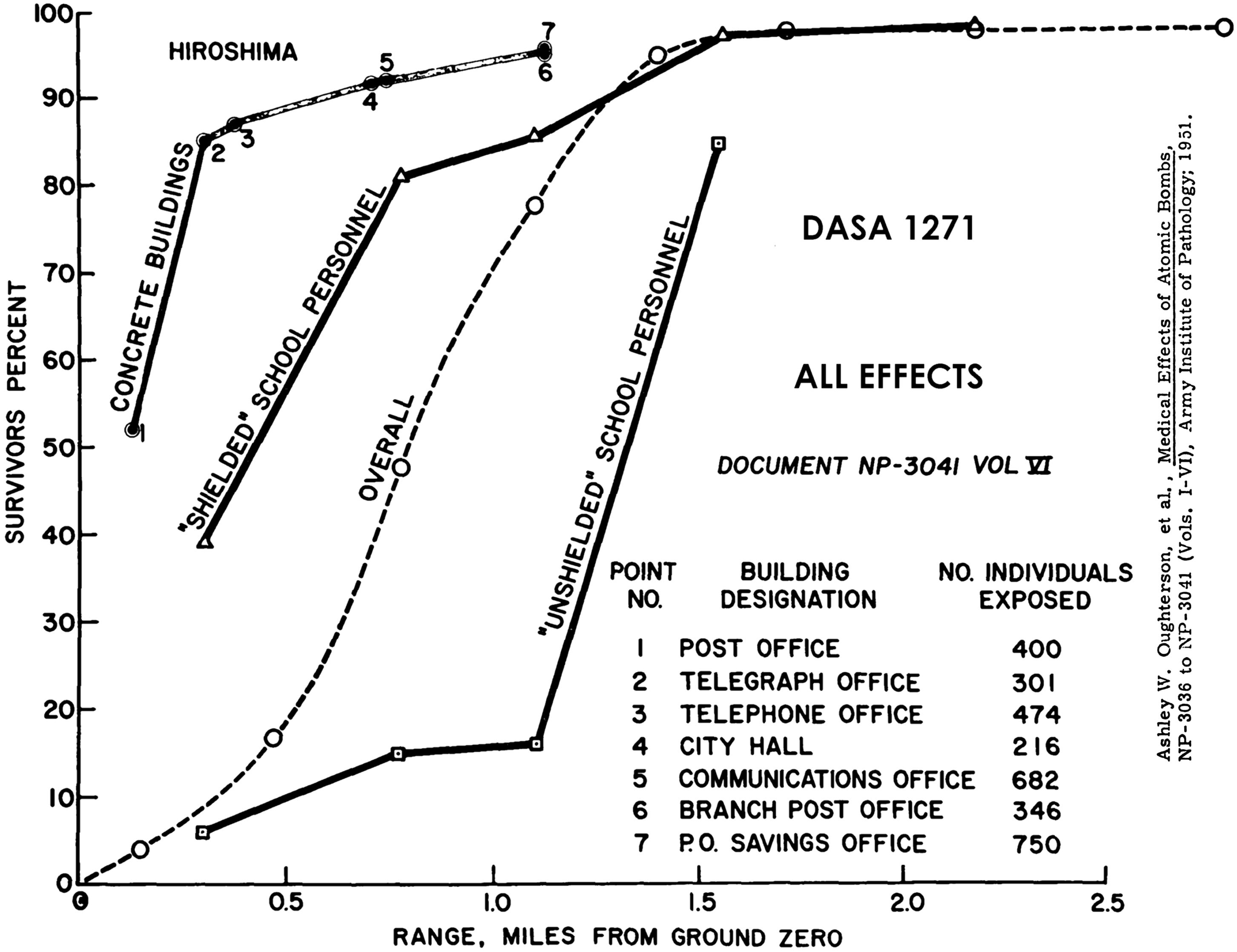
(UK Home Office Scientific Advisory Branch)

During the last war, a total of 1,300,000 tons* of bombs were dropped on Germany by the Strategic Air Forces. If there were no increase in aiming accuracy, then to achieve the same total amount of material damage (to houses, industrial and transportation targets, etc.) would have required the use of over 300 atomic bombs together with some 500,000 tons of high explosive and incendiary bombs for targets too small to warrant the use of an atomic bomb.

This figure for the weight of H.E. equivalent to the atomic bomb for causing casualties increases as the amount of protection of the population increases. Thus for the night raiding conditions on London in the last war, where something like 60% of the population were in houses, 35% in shelter and 5% in the open, the number killed in inner London per ton

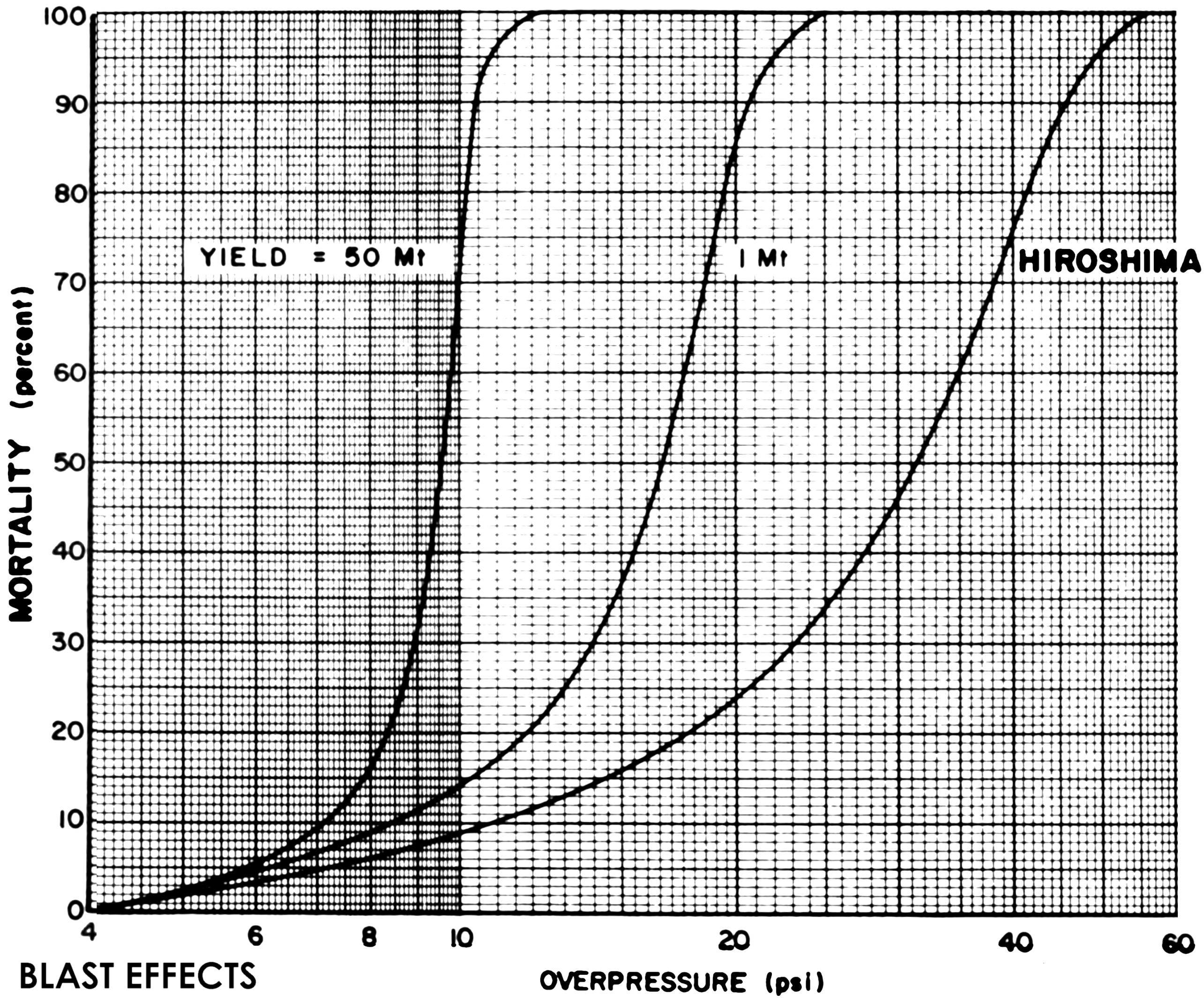
of bombs was about 4. For corresponding conditions of exposure it is considered that the deaths from an atomic bomb would be of the order of 25,000, giving an H.E. equivalent of just over 6,000 tons. Taking, therefore, 6,000 tons as the average equivalent for last war conditions of exposure in this country, we get that the 75,000 tons of bombs dropped by the German Air Force were equivalent for causing casualties to about 12 atomic bombs dropped with the accuracy actually achieved by the G.A.F., or to about 3 atomic bombs accurately placed at the centres of big cities.

a much greater total area of damage would be achieved by splitting the mass up and having a number of small explosions rather than one very large explosion. This, of course, is what happened in air attacks with high explosive bombs in the last war.



Ashley W. Oughterson, et al., Medical Effects of Atomic Bombs, NP-3036 to NP-3041 (Vols. I-VI), Army Institute of Pathology; 1951.

DC-P-1060 **NONSEISMIC REINFORCED-CONCRETE BUILDINGS**



BLAST EFFECTS

L. Wayne Davis, Donald L. Summers, William L. Baker, and James A. Keller, Prediction of Urban Casualties and the Medical Load from a High-Yield Nuclear Burst, DC-FR-1060, The Dikewood Corporation

CD 2333

~~SECRET~~

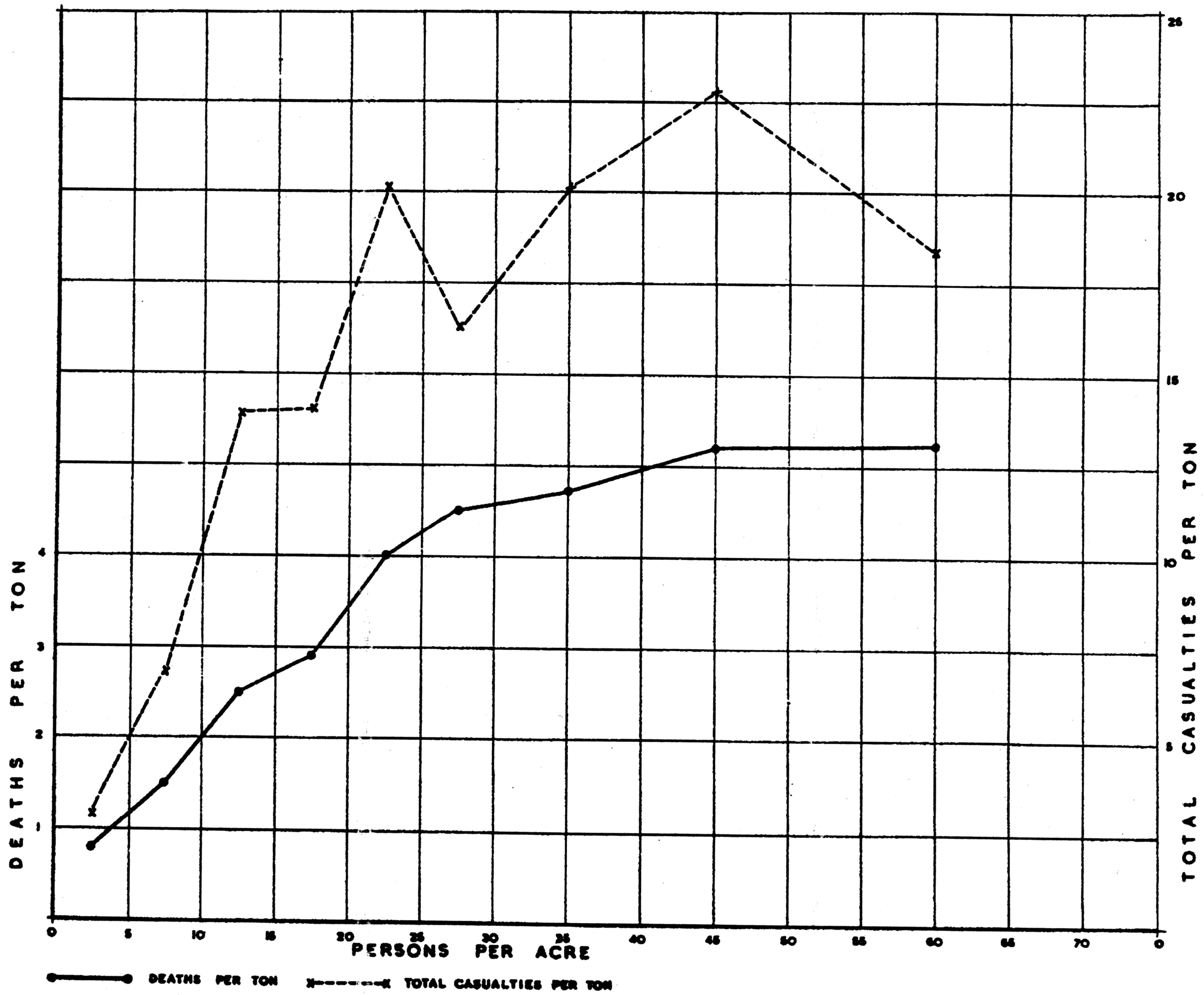
HOME OFFICE

CD/SA 12
Copy. No 5.

OFFICE OF THE CHIEF SCIENTIFIC ADVISER

A COMPARISON BETWEEN THE NUMBER OF PEOPLE KILLED PER TONNE OF BOMBS DURING WORLD WAR I AND WORLD WAR II

FIG 1 DENSITY OF POPULATION AND CASUALTIES PER TON OF H.E'S. & MINES IN LONDON REGION IN JANUARY TO MAY 1941



BOMB SIZES

=> ≈ 175 kg

For World War II the average bomb weight was between 150 - 200 kg. (R.C. 268, Table 6), whereas for World War I the majority of bombs were 12 or 50 kg. It is known that in World War II the smaller bombs (50 kg.) certainly did not cause fewer deaths per tonne than the larger bombs. Thus on size alone we should expect a higher death rate in World War I if anything.

For the country as a whole the death rate per tonne for World War I was 5.8 times that for World War II. When the comparison is reduced to comparable areas (roughly the county of London) this factor is reduced to 4.25. Differences in population density in the two wars are shown to account for a factor of nearly 2 and differences in exposure for a further factor of 1.5 to 2.

Total casualties include killed and injured

TABLE 1

Casualty rates per tonne for all bombs dropped during the two wars

	Tonnes dropped		Killed		Killed/ tonne		Total ✓ casualties		Casualties/ tonne	
	14/18	39/45	14/18	39/45	14/18	39/45	14/18	39/45	14/18	39/45
Whole country	301.8	74,900	1,414	60,595	4.7	.81	4,830	146,777	16.0	1.96
London	62.8	14,800	670	30,300	10.7	2.02	2,630	80,000	41.8	5.41
Remainder	239.0	60,100	744	30,300	3.1	.50	2,200	66,700	9.2	1.11

TABLE 2

Killed rates, London County, for both wars

	Tonnes dropped	Killed	Killed/ tonne
1915/17	19.6	349	17.8
1939/45	3591	15,171	4.2

POPULATION DENSITY

For equal conditions of exposure (i.e. in houses or shelters) it would be expected that the casualties from a bomb would be directly proportional to the density of population round the bomb. This was borne out by the experience of World War II as shown for example in Fig. 1 (taken from R.E.N. 544). It will be seen that deaths per tonne tend to be proportional to population density up to a density of about 25 persons/ acre but that thereafter the rate of increase in death rate with population density is reduced. Two factors might account for this: the greater population densities are associated with greater building densities, and these should provide some measure of shielding, thus reducing the casualty rates. Alternatively in the more densely populated areas more people are known to have gone to shelter, and this again would reduce the casualty rate.

Now in World War I London was more densely populated, and a substantial proportion of the discrepancy between the figures for the two wars is undoubtedly due to this cause.

Mean ratio of densities $\frac{\text{W.W.I}}{\text{W.W.II}} = 1.94.$

TABLE 5

Relative safeties in World War II deduced from population and casualty distribution

	In the open	Under cover	In shelter
Population exposure	5%	60%	35%
Location people killed	19%	62%	19%
Relative safety	72%	20%	10%

These values are:-

(1) A house about $3\frac{1}{2}$ times as safe as in the open.
(2) A shelter about twice as safe as a house.

TABLE 6

Relation between various population exposures and death rate for World War I compared with known exposure for World War II

	Population exposure			Ratio $\frac{\text{death rates W.W.I}}{\text{" " W.W.II}}$	Location of killed		
	% in open	% in cover	% in shelter		% in open	% in cover	% in shelter
World War II	5	60	35	1	19	62	19
Possible distribution for World War I	10	90	-	1.33	29	71	-
	20	80	-	1.60	48	52	-
	30	70	-	1.88	61	39	-
	40	60	-	2.15	71	29	-

Table 6 also shows the location of killed which is implied by each of the possible population exposures. The only evidence available on this point is that, for the day raid on June 13th, 1916, in which the total number killed was 59, 69.5% of the people killed in the City were in the open. This very limited evidence would imply a ratio of death rates equal to about 2.

It must be remembered that while there were no shelters as such in 1914, basement windows were sandbagged and people encouraged to use them. The tubes were also in use to some extent (Jones' "War in the Air", Vol. V, 109, 134). The information which is available suggests that not more than 3% used shelters. On this basis the assumption of no one in shelter will not appreciably affect the results of Table 6.

Bearing in mind that a day-time public warning system was not introduced until June, 1917 and that the enemy was using a new weapon for which the public was not adequately prepared it is not unreasonable to suppose that a high percentage of people were in the open. The Government of the time actually expressed concern at the public coming into the open when warnings sounded (Jones' "War in the Air", Vol. III, p.179).

CD. 1554.

NOTES ON THE OCCUPANCY OF SHELTERS DURING ATTACK BY V.1 WEAPONS ON LONDON - 1944

For the purposes of the assessment to be carried out by the Civil Defence Joint Planning Staff's Working Party on the effects of a heavy air attack on London it was desirable to obtain some basis for estimating the number of people who might be expected to take shelter in the event of attack by V.1 weapons.

No survey having this particular aim had been carried out but some of the data collected during a survey in the Borough of Wandsworth (1944) to determine the effectiveness of various types of shelter against V.1 attack offered some chance of arriving at a reasonable conclusion. The survey extended over the period 18th June 1944 to 28th August 1944, included approximately 100 incidents and involved the examinations of about 200 Morrison shelters, 700 Anderson shelters, 50 brick surface shelters and also some miscellaneous types. Only shelters within 170 ft. of the explosion were examined and the data is confined to such cases.

Of the 100 incidents investigated by the survey team 57 of them gave rise to reports on 428 Anderson shelters which were accepted for present purposes. The reports cover incidents whenever they occurred in the 24 hours.

The number of people to whom these shelters were accessible amounted to 1,471. The numbers who sheltered or remained in the houses were 853 and 618 respectively. Thus the percentage who took shelter was 58%. These figures confirm a previous estimate based on this data although the method of working could not be traced. The previous estimate referred to was expressed as follows:-

Anderson Shelters:-
Occupancy during daylight hours (0600 hours to 23.00 hours). 48%.
Occupancy during night hours 69%.

Morrison Shelters:-
Occupancy during daylight hours 69%.
Occupancy during night hours 76%.

Underground Stores + Tunnels.
Tube Stations + Shelters. General.

RE/B 62/5/1

....
(R. R. Welch)

10th September 1948

PUBLIC SHELTER OCCUPANCY

A12, ~~SD~~ 2 1

Local Authority	Bunks installed	EAST Occupants On 26/6/44	Occupants On 25/9/44	Public Shelters On dates between 17/12/44 & 7/1/45	
Shoreditch	13,903	5,595	1,598	932	(27/12/44)
Dagenham	3,984	1,000	120	24	(17/12/44)
Hackney	13,467	11,624	4,427	1,535	(22/12/44)
East Ham	3,939	2,078	1,073	874	(18/12/44)
Stepney	22,898	16,915	4,762	3,769	(27/12/44)
Wanstead	2,385	1,819	945	484	(1/1/45)
Leyton	7,144	4,894	1,959	1,471	(18/12/44)
	67,720	43,925	14,884	9,089	
NORTH					
Enfield	5,574	1,705	384	64	(20/12/44)
Potters Bar	522	92	63	75	(19/12/44)
Elstree	528	1	nil	nil	(27/12/44)
Friern Barnet	553	387	47	105	(20/12/44)
Islington	17,085	18,676	2,770	2,000	(7/1/45)
Hendon	7,677	2,621	364	223	(18/12/44)
	31,939	23,482	3,628	2,467	
WEST					
Staines	1,023	982	88	49	(18/12/44)
Heston	8,178	5,362	987	314	(20/12/44)
	9,201	6,344	1,075	363	
NORTH WEST					
Willesden	9,135	4,257	640	371	(18/12/44)
Ruislip	2,631	936	17	nil	(26/12/44)
	11,766	5,193	657	371	
SOUTH					
Woolwich	4,929	3,919	1,413	1,457	(18/12/44)
Wandsworth	21,862	17,701	3,876	1,859	(21/12/44)
Southwark	8,871	21,834	5,450	2,789	(22/12/44)
Chislehurst Caves	10,000	10,000	1,846	1,800	(3/1/44)
	45,662	43,454	12,585	7,905	
Total	166,288	122,398	32,829	20,195	
	Capacity of bunks used	74%	20%	12%	

PUBLIC SHELTERS (CAVES & TUBES) (UNDERGROUND RAILROAD IN LONDON)

SHELTER USAGE

	Before Fly Bombs	At height of Fly Bombs	Present Time	
Bermondsey	823	11,960	4,780	
Deptford	-	4,429	2,489	
Greenwich	447	3,879	1,615	
Lewisham	209	6,745	2,090	
Woolwich	183	4,926	1,509	
Total Group 4	4,215	31,939	12,483	39%
Barking	163	1,769	694	
Chigwell	6	669	140	
Chingford	-	1,075	227	
Dagenham	-	797	66	
East Ham	300	2,251	1,019	
Ilford	522	3,165	853	
Leyton	-	4,600	1,834	
Waltham Holy Cross	Nil	93	8	
Walthamstow	1,400	3,913	1,708	
Wanstead	104	1,868	621	
West Ham	1,300	8,035	2,974	
Total Group 7		28,235	10,144	36%
Finsbury	-	9,500	1,374	
Holborn	159	4,210	417	
St. Pancras	228	12,700	1,791	
Orpington	-	500	100	
Barnes	Nil	400	100	
Malden & Coombe	-	1,100	100	
Croydon	1,500	9,800	2,290	
Wandsworth	1,050	34,381	3,372	
Coulsdon	-	500	65	
Stepney	-	25,000	7,000	
Total Misc.		98,091	16,609	17%
British Museum	106	565	175	
Kentish Town Disused	65	1,280	440	
Southwark Deep	866	6,042	1,435	
West Ham Tunnel		1,813	520	
West Down "		1,200	385	
Gainsboro' "		1,539	574	
Bethnal Green Tunnel	854	4,170	2,150	
Liverpool Street "	672	930	782	
Aldwych	285	1,346	498	
Deep Shelters (Inner) Total		18,885	6,959	37%
Chislehurst Caves		10,000	1,900	
Surrey Tunnels				
Riddlesdown	850	1,700	500	
Brighton Road	Nil	600	20	
Epsom Downs	Nil	400	25	
Ashley Road	Nil	250	20	
Deep Shelters (Outer) Total		12,950	2,465	19%
Running Tubes	7,716	73,611	15,968	22%
New Tubes	-	10,727	5,998	56%
		84,338	21,966	26%

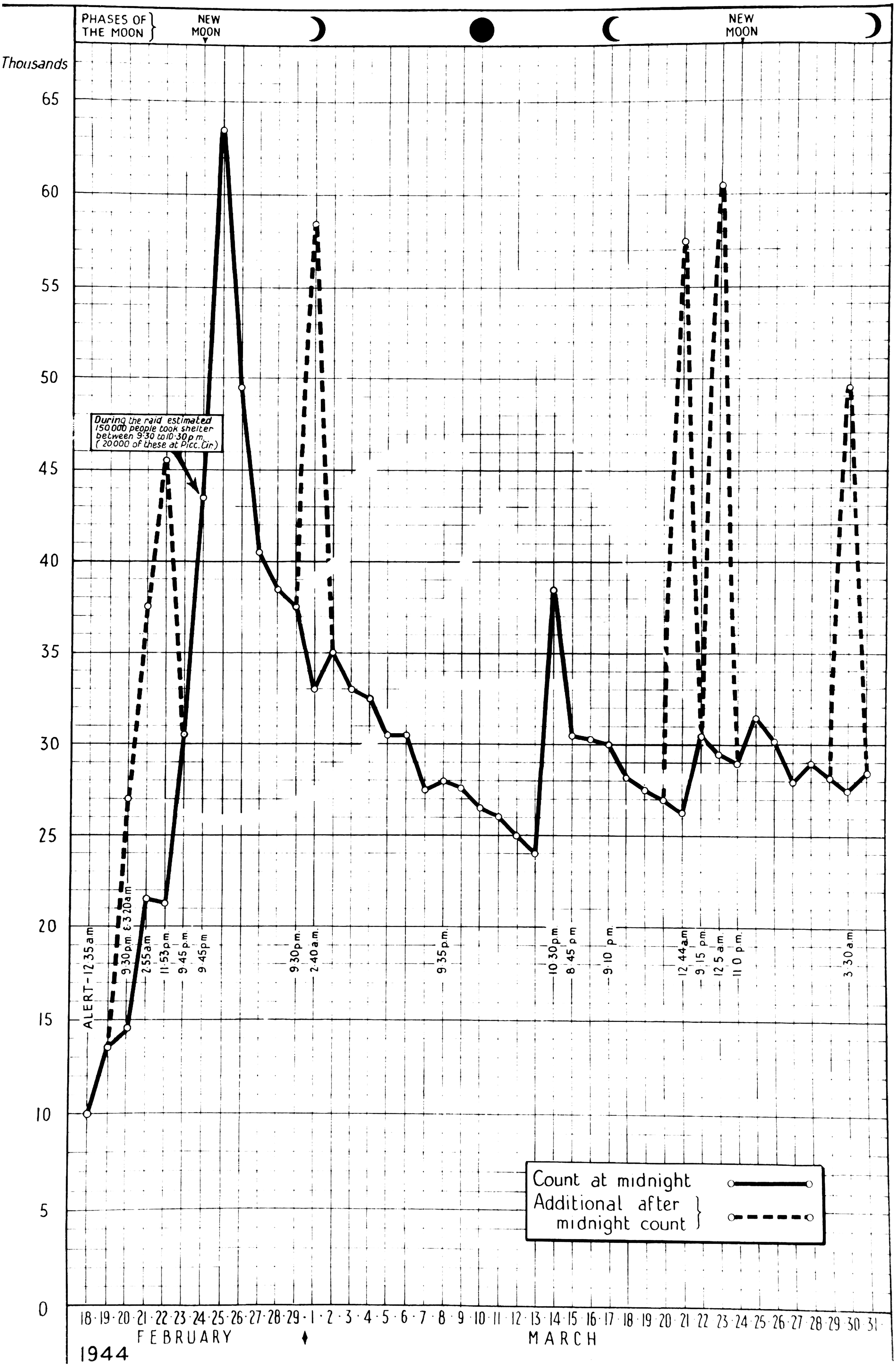
15th November, 1944.
Copied 18/12/45 - LH.

UK National Archives: HO 207/386

NUMBER OF TUBE STATION SHELTERERS
(INCLUDING LIVERPOOL STREET, ALDWYCH AND BETHNAL GREEN)

SECOND BLITZ - FEB. 18th. TO MARCH 31st. 1944

NUMBER OF LONDON ALERTS - 18



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3 OCTOBER 1963

HOME OFFICE

SCIENTIFIC ADVISER'S BRANCH

CD/SA 116

RESEARCH ON BLAST EFFECTS IN TUNNELS

With Special Reference to the Use of London Tubes as Shelter

by F. H. Pavry

Summary and Conclusions

The use of the London tube railways as shelter from nuclear weapons raises many problems, and considerable discussion of some aspects has taken place from time to time. But - until the results of the research here described were available - no one was able to say with any certainty whether the tubes would provide relatively safe shelter or not.

This research, consisting of a series of model experiments, has demonstrated that the risk from blast in the tubes would be less than the risks above ground. The results are considered to be consistent enough to provide a good estimate of full-scale conditions, and reliable enough to be used as a basis for Home Office shelter policy regarding the London tube railways.

Introduction

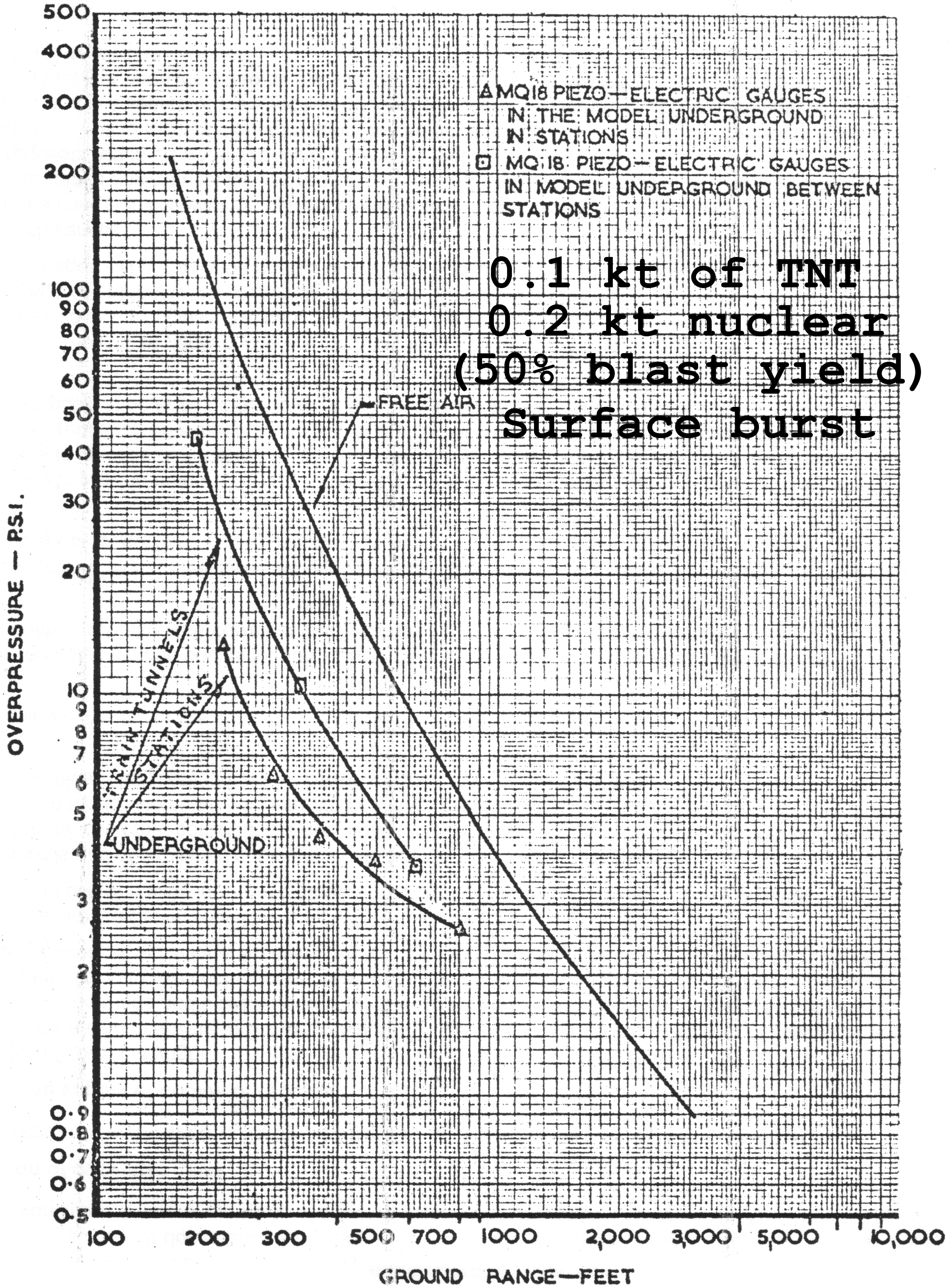
When the Advisory Group on Structural Research for Civil Defence was formed in 1957, the Chairman recommended that a study of the effects of blast on tunnels should be one of the main research projects. The relevant paragraphs of his proposals(1) for a research programme were:-

> "In any consideration of tunnels as shelter the crucial problem is the entry of blast, either through existing openings or from a crater formed by a ground-burst bomb. It is particularly important to know if the collapse of a tunnel by earth shock would prevent the blast from entering it, and also whether the collapse would provide a seal against the entry of water from the crater. It is probable that some data could be derived from model experiments using H.E. charges. But it is for consideration whether the results would be so conclusive that the behaviour of full-size tunnels when damaged by megaton weapons could be forecast with the confidence that a major shelter programme would demand."

At the second meeting(2) the Group agreed that model experiments with H.E. charges would be worthwhile, and that the Atomic Weapons Research Establishment (A.W.R.E.) should carry out this research, which has now been accepted by the Advisory Group as successfully completed. A summary record of the progress follows.

~~RESTRICTED~~

100 ton TNT test on 1000 ft section of London Underground tube at Suffield, Alberta, 3 Aug 1961



Atomic Weapons Research Establishment, "1/40th Scale Experiment to Assess the Effect of Nuclear Blast on the London Underground System", Report AWRE-E2/62, 1962, Figure 30. (National Archives ES 3/57.)

These trials are described in a preliminary report[5] prepared for the Advisory Group by A.W.R.E. It was shown that the blast pressure inside a tunnel system, having openings at intervals to ground level, is less than the pressure at ground level at any distance from the explosion, by a factor of about 3. This reduction in pressure was apparently caused by the station entrances acting as expansion chambers. This observation was of outstanding significance to the consideration of London tubes as shelter.

All previous research on blast in tunnels - and a great amount of work was done on this in the last war - had been conducted with blast entering the open end of a tunnel without side openings. This research had shown that the blast, once it had got into a tunnel, tended to travel great distances without appreciable diminution. This had, therefore, led to the general belief that the London tubes could be death traps rather than shelters.

The more recent research here described showed for the first time that a person sheltering in a tube would be exposed to a blast pressure only about $\frac{1}{3}$ as great as he would be exposed to if he was above ground. (In addition, of course, he would be fully protected from fallout in the tube.)

In fact A.W.R.E. carried out two further tests, with more accurate scaling of station volumes based on more detailed information from the London Transport Executive. A full report on all four tests is in preparation.

These later tests showed that the pressure in station tunnels was only about 1/6th of the ground-level pressure, but that the reduction was not so great in the smaller-diameter train tunnels.

At this stage the Advisory Group were reasonably satisfied that this problem - of blast entry from stations - had been solved. But the other major question of blast entry direct from the crater remained in doubt, on account of the very small scale of the tests to date. Therefore, when the opportunity arose of testing at a really large scale at Suffield, Canada, it was naturally accepted.

Large-Scale Field Test (1/40) at Suffield, Alberta

The test is fully described in an A.W.R.E. report[6]. The decision of the Canadian Defence Research Board to explode very large amounts of high explosive provided a medium for a variety of target-response trials that was welcome at a time when nuclear tests in Australia were suspended. A.W.R.E. used the 100-ton explosion in 1961 to test, among other items, the model length of the London tube, at 1/40th scale, that had already been tested at 1/117 scale.

Blast Entry from Stations

There was remarkable agreement with the 1/117th scale trials: "maximum overpressure in the train tunnels was of the order of $\frac{1}{3}$rd the corresponding peak shock overpressure in the incident blast. The pressures in the stations were about 1/6th those in the corresponding incident blast .... ". In comparing the results at the two scales it was noted that the pressures in the train tunnels (between stations) was higher at Suffield than at the smaller scale; this may, the report suggests, have been due to some blast entry from the crater at Suffield.

Blast Entry from the Crater

There may - as has just been noted - have been some entry of blast at the crater. But the all-important fact is that it was nowhere enough to bring the pressure in the tunnel up to more than a $\frac{1}{3}$rd of the free-air pressure (see fig. 30 reproduced, and attached to this note.) From this, and from a detailed study of tunnel rings ejected by the explosion over a wide area, it can be concluded that the instantaneous crushing of the tube near the crater sealed it against the entry of any significant blast pressure.

Air Flow in Stations

The Report indicates that there would be turbulence generated by blast entry at stations and that there would be a danger to occupants there, on account of blast "windage" acting on them and on missiles that could injure them. This danger would be less in the train tunnels between stations.

Conclusion

The Advisory Group discussed the Suffield Test on tunnels on Nov. 1st 1962, and concluded that model experiments have successfully demonstrated that the risks from blast inside the London tubes would be less than above ground. The Group considered that the results obtained were consistent enough to provide as good an estimate of full-scale effects from megaton weapons as was likely to be obtainable, and that the Chairman could advise the Home Office confidently on the basis of these results. The Group accepted that there would be a risk of casualty-producing air flow in stations, but decided to defer a decision on whether further research on this problem would be profitable. The Chairman said that he would first convey the results of the completed research to the Shelter Division of the Home Office before asking the Group whether it was worth studying this remaining, but less important, problem.

3rd October, 1963.

References

(1) Advisory Group on Structural Research for Civil Defence

Note by Chairman on the Structural Research Programme for Shelters. SAB/SG(57)6. (Restricted)

(2) Notes of Meeting on 15th May 1957. SAB/SG(57)2nd Minutes (Confidential)

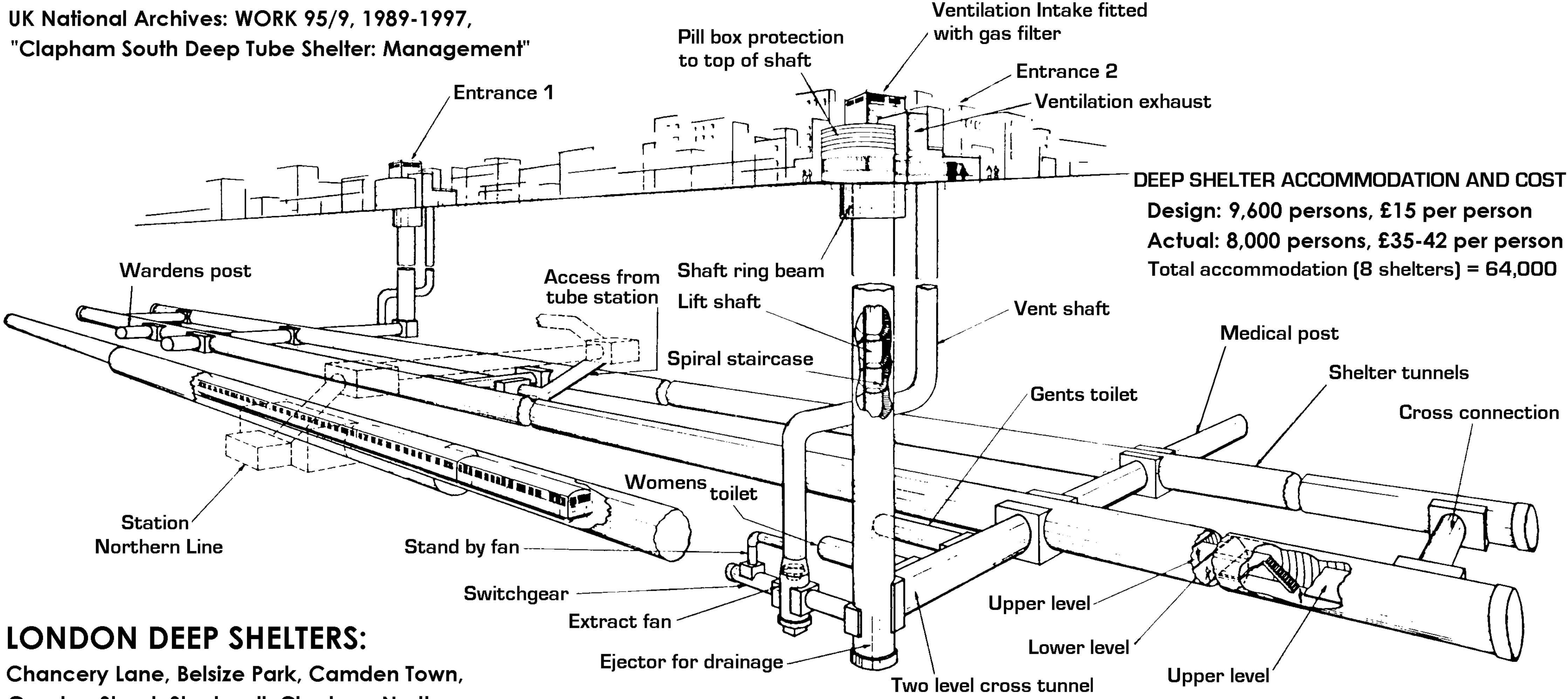
(3) The Entry of Air Blast from Craters into Tunnels. A.W.R.E. Report E1/59 (Official Use Only)

(4) The Effect of Tunnel Blockage on Shock Waves .... SAB/SG(58)6 (Confidential)

(5) Model Experiments on the Entry of Blast into the London Underground System, Interim Report on Rounds 1 and 2. SAB/SG(59)4 (Confidential)

(6) 1/40th Scale Experiment to Assess the Effect of Nuclear Blast on the London Underground System. A.W.R.E. Report E2/62. (Official Use Only.)

UK National Archives: WORK 95/9, 1989-1997,
"Clapham South Deep Tube Shelter: Management"



DEEP SHELTER ACCOMMODATION AND COST

Design: 9,600 persons, £15 per person

Actual: 8,000 persons, £35-42 per person

Total accommodation (8 shelters) = 64,000

LONDON DEEP SHELTERS:

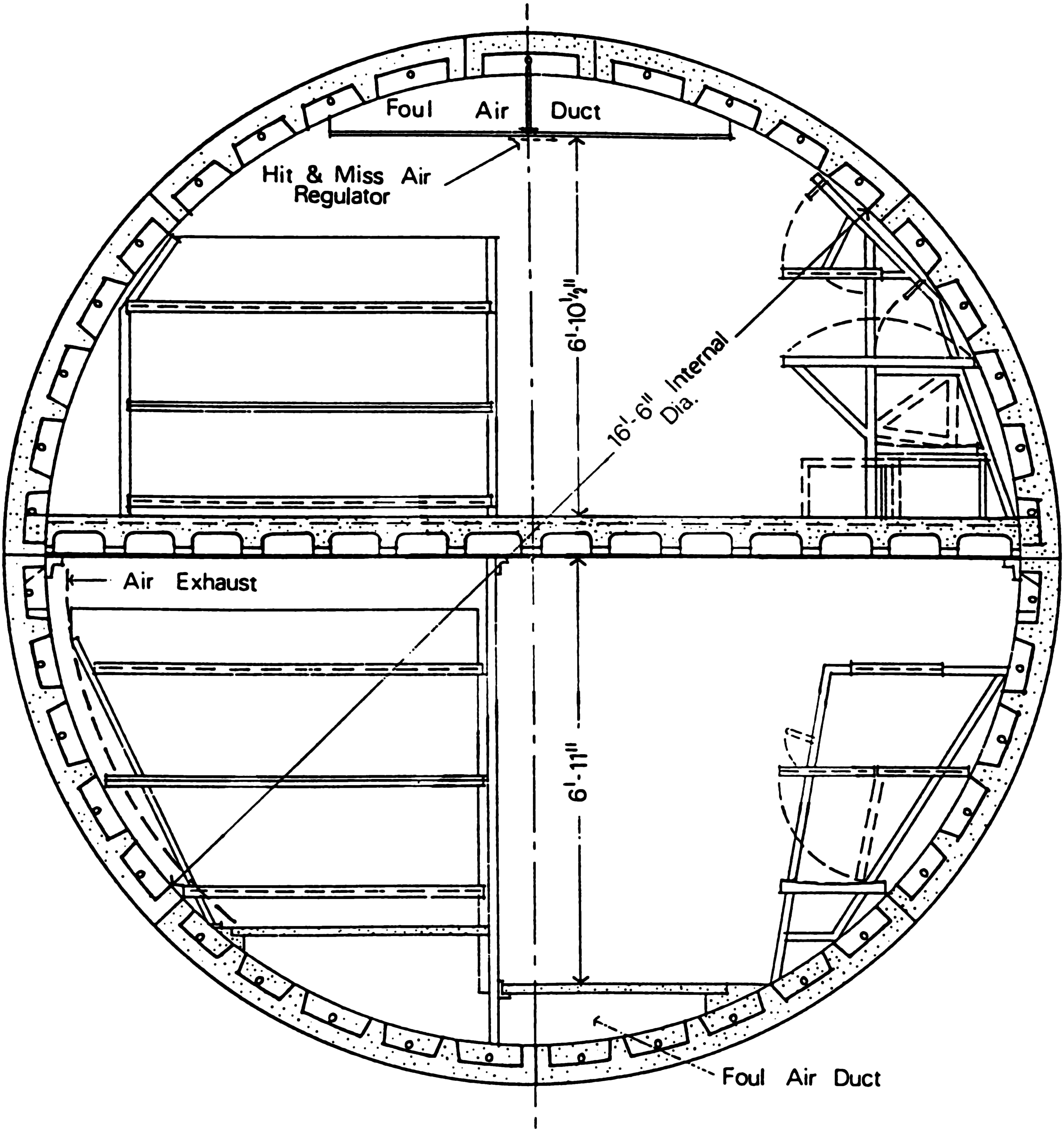
Chancery Lane, Belsize Park, Camden Town, Goodge Street, Stockwell, Clapham North, Clapham Common, Clapham South (government air raid shelters, built in 1940-2) Building began on 27 November 1940

Deep shelters were used by public from July 1944 after V1 attacks began on 13 June 1944 (V2s began on 8 September)

FIG. 1

MOTT MAY AND ANDERSON
CONSULTING ENGINEERS, LONDON

UK National Archives: WORK 95/9, 1989-1997,
"Clapham South Deep Tube Shelter: Management"



SECTION OF SHELTER TUNNEL

DOMESTIC NUCLEAR SHELTERS

TECHNICAL GUIDANCE

A HOME OFFICE GUIDE

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Southey House, Wine Street, Bristol BS1 2BQ
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Second Edition 1982

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Printed in England for Her Majesty's Stationery Office by Hobbs the Printers of Southampton

ISBN 0 11 340777 7 (2462) Dd717557 C40 1/82 G381

Introduction

This manual of technical guidance on the design of domestic nuclear shelters has been prepared by a working group set up by the Emergency Services Division of the Home Office. The working group was asked to consider designs of nuclear shelters which could be made available to members of the public in the United Kingdom who might wish to purchase and install shelters for the use of themselves and their families.

The working group realised that the range of designs which it might produce would not be exhaustive. However, it was aware of the need to give technical guidance to professional engineers to assist them in producing reliable shelter designs. Thus the first three chapters of this book are written to give such guidance.

The other four chapters of the book give detailed designs of five shelters. These five cover a range of types which are applicable to different sorts of houses; they also cover a wide price range. These designs are not intended to be exhaustive, and as explained in the text, the working group is already giving attention to other designs, particularly those which might be incorporated into existing or new houses and also underground shelters of shapes other than box-like and using materials other than concrete. It is planned to publish details of this work at a later date.

The members of the working group are:

Mr J C Cotterill, *Chairman*	Scientific Advisory Branch, Home Office
Dr J R Stealey	Scientific Advisory Branch, Home Office
Mr A Lindfield	Scientific Advisory Branch, Home Office
Mr K A Day	F6 Division, Home Office
Mr R W T Haines, C Eng	Directorate of Works, Home Office
Mr H G S Banks, C Eng	Directorate of Works, Home Office
Mr M Connell, C Eng	Directorate of Civil Engineering Services Property Services Agency, Department of Environment
Mr S Bell, C Eng	Directorate of Civil Engineering Services Property Services Agency, Department of Environment
Mr S England, C Eng	Directorate of Mechanical and Electrical Engineering Services Property Services Agency, Department of Environment
Mr I Leys	Atomic Weapons Research Establishment, Ministry of Defence Foulness
Major I C T Ingall	HQ United Kingdom Land Forces Wilton, Wilts.
Mr R Million, *Secretary*	F6 Division, Home Office

Any enquiries concerning this manual should be addressed to the Home Office, F6 Division, and not to individual members of the working group.

To obtain some protection from the heat it is necessary to move out of the direct path of the rays from the fireball; any kind of shade will be of some value. In shelter design, any materials affording protection against ionising radiation or blast will give more than adequate protection against the heat. However it is important to ensure that no exposed parts of the shelter (such as the facings of doors) are made of flammable materials. In the case of shelters made from plastic materials such as GRP (glass reinforced plastic) it is essential that no surfaces should be exposed to the heat pulse. It is unlikely that such plastic materials would catch fire, but they may melt or distort. Since the blast wave follows the heat pulse, such distorted areas may result in lowered blast resistance.

It is considered unlikely that the heat flash from a nuclear explosion would give rise to fire-storms. In the last war, fire-storms were caused in the old city of Hamburg as a result of heavy incendiary attacks and at Hiroshima but not at Nagasaki. A close study of these cities and of German cities where fire-storms did and did not occur revealed several interesting features. A fire-storm occurred only in an area of several square miles, heavily built up with buildings containing plenty of combustible material and where at least every other building in the area had been set alight. It is not considered that the initial density of fires, equivalent to one in every other building, would be caused by a nuclear explosion over a British city. Studies have shown that due to shielding, a much smaller proportion of buildings than this would be exposed to the heat flash. Moreover, the buildings in the centres of most British cities are now more fire-resistant and more widely spaced than they were 30 to 40 years ago. This low risk of fire-storms would be reduced still further by the control of small initial and secondary fires.

2. Shielding for INR

INR has greater energy and penetration than the radiation from fallout. The intensity of both INR and fallout radiation are reduced in proportion to the density of the shielding material. This can be expressed in terms of the 'half-value thickness' which is the thickness of a particular shielding material required to halve the radiation dose-rate. The approximate half-value thicknesses of some shielding materials against INR are given in Fig. 8.

Fig. 8 ***Half-value thicknesses of shielding materials***

	Against INR		Against fallout radiation	
	mm	(inches)	mm	(inches)
Steel	38	(1.5)	18	(0.7)
Concrete	152	(6.0)	56	(2.2)
Earth	190	(7.5)	84	(3.3)
Water	330	(13.0)	122	(4.8)
Brickwork	157	(6.2)	71	(2.8)

3. Slant incidence of INR

Most of the INR from a nuclear explosion arriving at a given point comes in a direct line from the fireball. There is a certain amount of scattering known as 'skyshine' which means that some initial gamma radiation might be received by a person shielded by a barrier from the light and heat flash (see Fig. 10). The amount of scattering of initial gamma radiation depends upon a number of factors, but probably amounts to about 10 per cent of that in the main beam.

Chapter 5
Indoor kit shelter design

"Morrison shelter" of 1941 (indoor steel table shelter)

General

This chapter gives information about an indoor shelter suitable for erection in homes that have basements or rooms that can be converted into a fallout room. It can be used as the 'inner refuge' referred to in the Home Office booklet *Protect and Survive* and anybody considering purchasing or using such a shelter should read *Protect and Survive* and be totally familiar with its contents.

Fig. 65 ***Location of shelter***

Indoor kit-type shelter

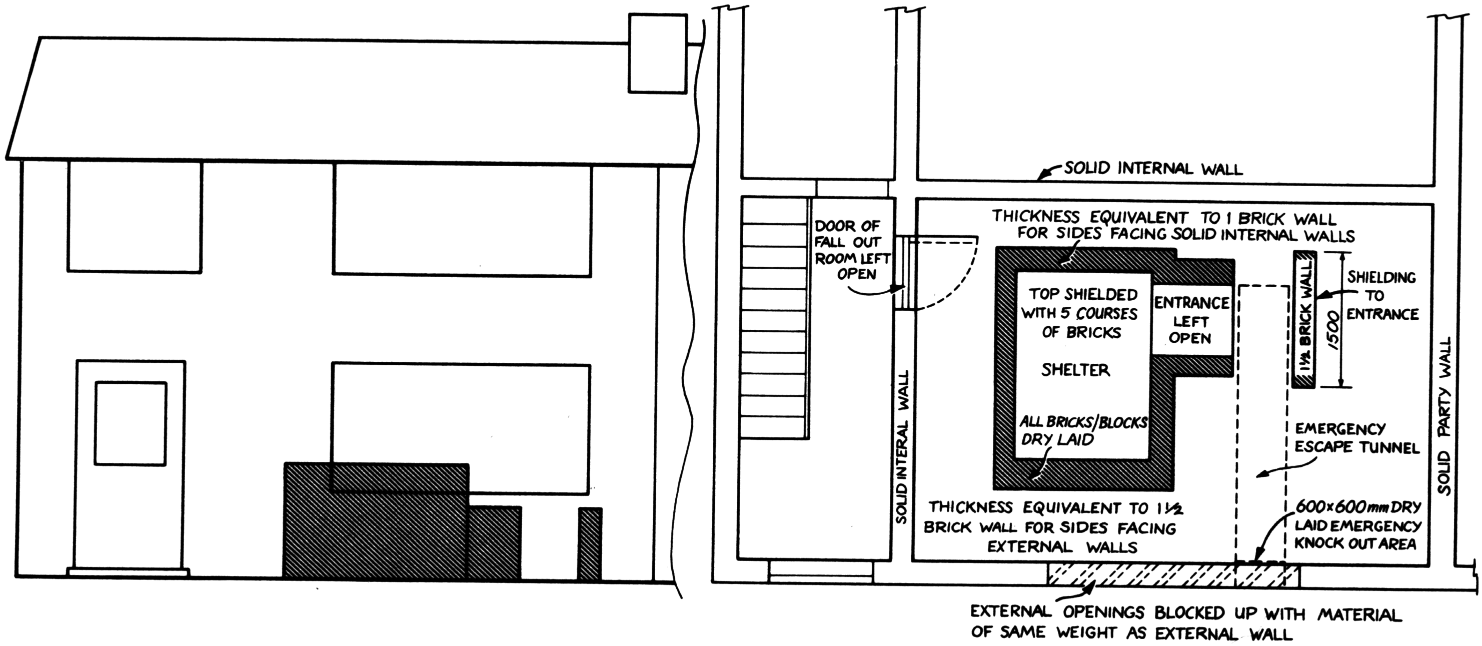


Fig. 67 ***Shelter surrounded with sandbags***

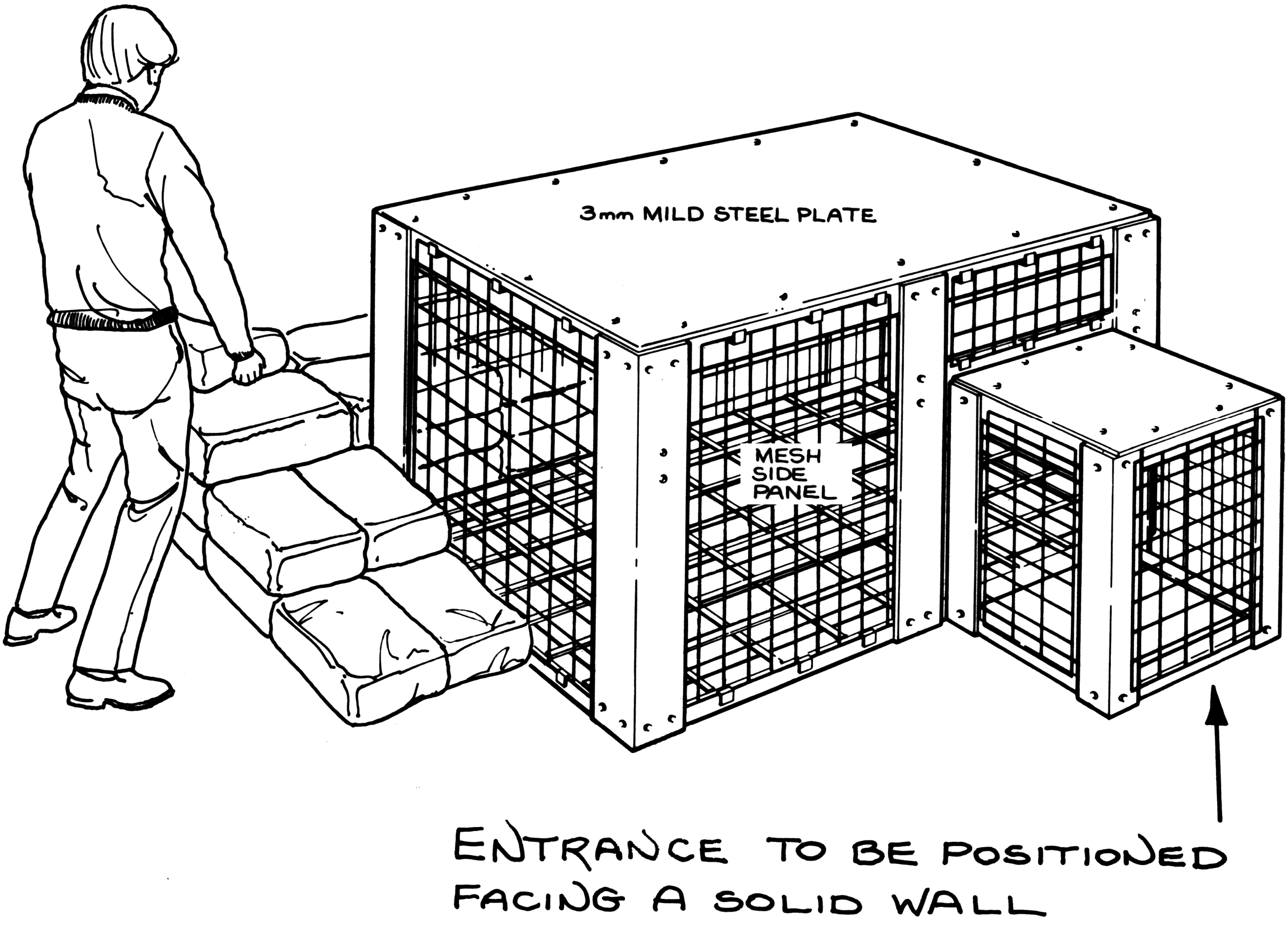


Fig. 12 ***Protective factors of various buildings against initial gamma, neutron and fallout gamma radiation***

Structure	Initial gamma	Neutrons	Fallout gamma
1 metre underground	250–500	100–500	5000
Shelter partly above ground: with 600 mm earth 900 mm earth	15–35 50–150	12–50 20–100	50–200 200–1000

Considerations arising from the probable attack pattern

In section 1.1.1 reference was made to the fact that an expected attack pattern on the United Kingdom might use 200 megatons on about 80 targets. If we now make an assumption that this attack would be in the form of 100 weapons of 1 MT airbursts and 100 weapons of 1 MT groundbursts we can use the information given in Fig. 6 to indicate the probability of areas being subject to various effects.

On this assumption, we should find that about 2.2 per cent of the land area of the UK would be subject to overpressures in the 'A' ring of 77 kPa (11 psi) and above about 1.8 per cent would be subject to overpressures of between 42 and 77 kPa (6-11 psi) in the 'B' ring and about 10 per cent of the land area would be subject to overpressures of between 10 and 42 kPa (1.5 to 6 psi). The rest of the land area, about 85 per cent, would be subject to blast in the D ring of 5 to 10 kPa (0.75 to 1.5 psi) or to no blast at all. Blast effects in the D ring will cause minor damage to buildings and no lethalities. It is impossible to determine the extent of the total D ring areas since many of these will overlap from adjacent bombs. Any part of the country might be subject to radiation from fallout.

Further comments on Home Office shelter designs

Chapters 4 to 7 of this book give details of the Home Office shelter designs and, where appropriate, detailed instructions for construction. It will be useful however to discuss here the reasons why this range of shelters has been chosen. Other designs are under consideration and it is planned to make details of these available later.

Limitations related to houses and gardens

In making recommendations for shelters it has been necessary to keep in mind the varying needs governed by the types of housing in the United Kingdom. Very roughly housing can be divided into the following groups:

a. Detached or semi-detached houses where there is appropriate access to the rear garden. (About 34%).
b. Semi-detached and terrace housing where there is no access to the rear garden, except through the house. (About 20%).
c. Houses with no rear garden. Such houses usually have a passage between the rows of terraces with access to a back yard. (About 25%).
d. Multi-storey blocks of flats. (About 12%).
e. Flats resulting from the conversion of 2, 3 and 4 storey houses. There is usually some garden space available attached to such property. (About 7%).
f. Bungalows, usually with accessible gardens. (About 2%).
g. Caravans.

Proceedings of the Symposium
held at Washington, D. C.
April 19-23, 1965 by the
Subcommittee on Protective Structures,
Advisory Committee on Civil Defense,
National Academy of Sciences—
National Research Council

Protective Structures for CIVILIAN POPULATIONS

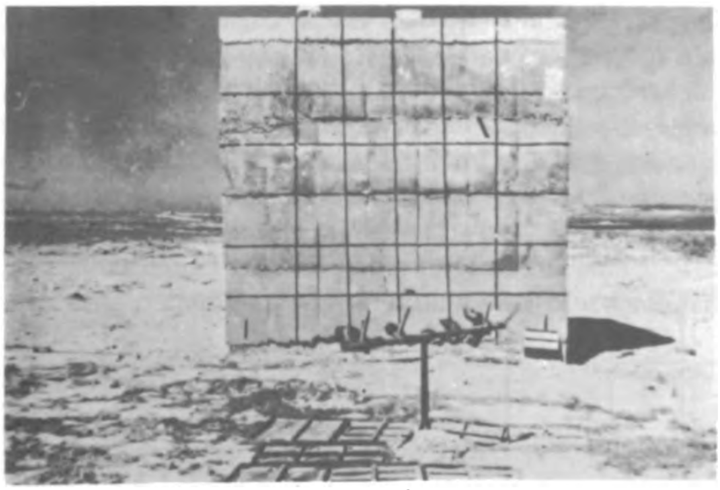
1966

MODEL ANALYSIS

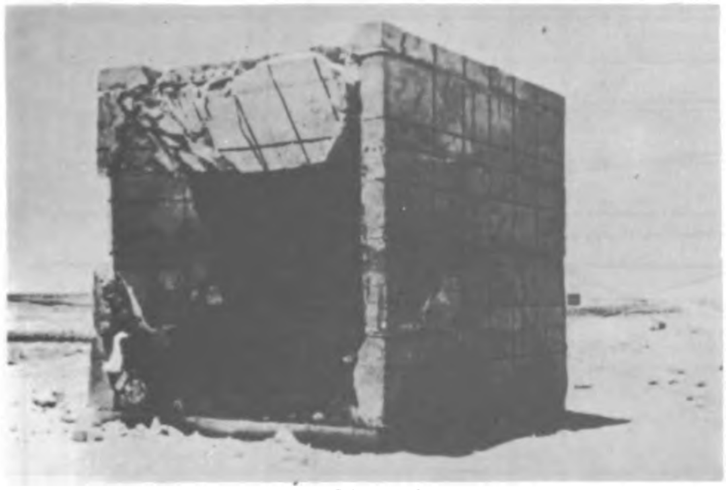
Mr. Ivor Ll. DAVIES
Suffield Experimental Station
Canadian Defense Research Board
Ralston, Alberta, Canada

Nuclear-Weapon Tests

In 1952 we fired our first nuclear device, effectively a "nominal" weapon, at Monte Bello, off northwest Australia. To the blast loading from this weapon we exposed a number of reinforced-concrete cubicle structures that had been designed for the dynamic loading conditions, and for which we made the best analysis of response we were competent to make at that time. Our estimates of effects were really a dismal failure. The structures were placed at pressure levels of 30, 10, and 6 psi, where we expected them to be destroyed, heavily damaged with some petaling of the front face, and extensively cracked, respectively. In fact, the front face of the cubicle at 30 psi was broken inwards; failure had occurred along both diagonals, and the four triangular petals had been pushed in. At the 10-psi level, where we had three cubicles, each with a different wall thickness (6, 9, and 12 in.), we observed only light cracking in the front face of that cubicle with the least thick wall (6 in.). The other two structures were apparently undamaged, as was the single structure at the 6-psi level.



10 p.s.i.



34 p.s.i.

Dynamic tests, Monte Bello cubicles.

In 1957, the first proposals were made for the construction of the underground car park in Hyde Park in London. The Home Office was interested in this project since, in an emergency, the structure could be used as a shelter. Consequently a request was made to us at Atomic Weapons Research Establishment (A.W.R.E.) to design a structure that would be resistant to a blast loading of about 50 psi, and to test our design on the model scale.

Using the various load-deformation curves obtained in this test, an estimate was made of the response of the structure to blast loading. Of particular interest was the possible effect of 100 tons of TNT, the first 100-ton trial at Suffield in Alberta.

A total of seven more models was made; six were shipped to Canada and placed with the top surface of the roof flush with the ground and at positions where peak pressures of 100, 80, 70, 60, 50, and 40 psi were expected. The seventh model was kept in England for static testing at about the time of firing. The results were not as expected. In the field, the four models farthest from the charge were apparently undamaged; we could see no cracking with the eye, nor did soaking the models with water reveal more than a few hair cracks. The model nearest the charge was lightly cracked in the roof panels and beams, and one of the columns showed slight spalling at the head. This model had been exposed to a peak pressure of 110 psi.

THE PROTECTION AGAINST FALLOUT RADIATION AFFORDED BY CORE SHELTERS IN A TYPICAL BRITISH HOUSE

Daniel T. Jones
Scientific Adviser, Home Office, London

Protective Factors in a Sample of British Houses (Windows Blocked)

Protective Factor	Percentage of Houses
< 25	36%
25-39	28%
40-100	29%
> 100	7%

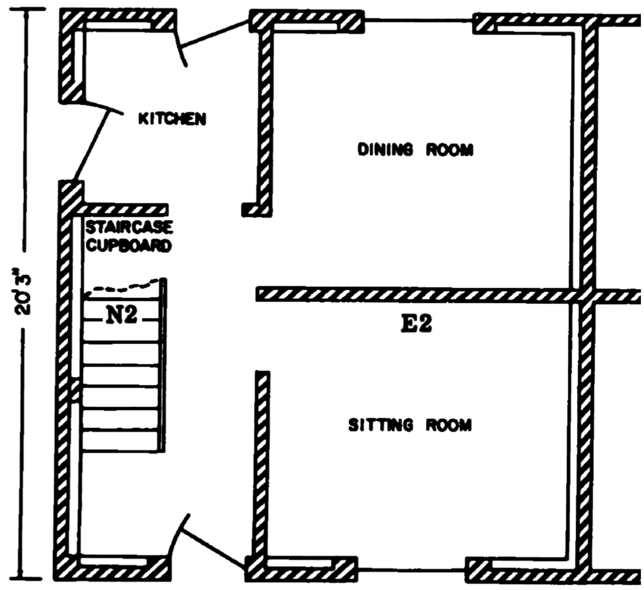
"A very much improved protection could be obtained by constructing a shelter core. This means a small, thick-walled shelter built preferably inside the fallout room itself, in which to spend the first critical hours when the radiation from fallout would be most dangerous."(1)

The full-scale experiments were carried out at the Civil Defense School at Falfield Park.(2)

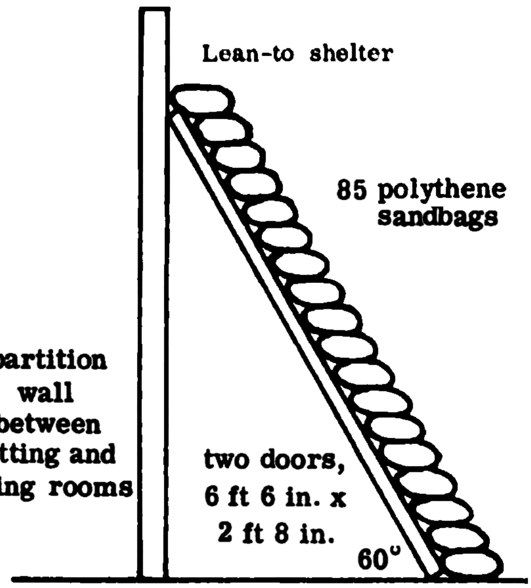
In the staircase construction, the shelter consisted of the cupboard under the stairs, sandbags being placed on treads above and at the sides.

A 93 curies cobalt-60 source was used.

1. Six sandbags per tread, and a double layer on the small top landing. 96 sandbags were used.
2. As (1), together with a 4-ft-high wall of sandbags along the external north wall. 160 sandbags were used.
3. As (2), together with 4-ft-high walls of sandbags along the kitchen/cupboard partition wall and along the passage partition. 220 sandbags were used.



sandbags 24 in. x 12 in. when empty; 16 in. x 9 in. x 4 in. when filled with 25 lb of sand.



floor area 21 sq ft.

9 in. brick walls The windows and doors were not blocked	Position	contribution r/hr/c/ft² Ground	Roof	Protective Factor
House only	E2	15.0	8.4	21
Lean-to	E2	10.4	2.4	39
Staircase cupboard:				
Stairs only sandbagged	N2	29.2	5.3	14
Stairs and outer wall sandbagged	N2	16.4	4.6	24
Stairs, outer wall, kitchen wall and corridor partition sandbagged	N2	8.8	1.8	47

1. Civil Defence Handbook No. 10, HMSO, 1963.
2. Perryman, A. D., Home Office Report CD/SA 117.

BLAST AND OTHER THREATS

Harold Brode
The RAND Corporation, Santa Monica, California

Chemical High-Explosive Weapons

As in past aerial warfare, bombs and missiles carrying chemical explosives to targets are capable of extensive damage only when delivered in large numbers and with high accuracy.

Biological Warfare

Most biological agents are inexpensive to produce; their effective dissemination over hostile territories remains the chief deterrent to their effective employment. Twenty square miles is about the area that can be effectively covered by a single aircraft; large area coverage presents a task for vast fleets of fairly vulnerable planes flying tight patterns at modest or low altitudes. While agents vary in virulence and in their biologic decay rate, most are quite perishable in normal open-air environments. Since shelter and simple prophylactic measures can be quite effective against biological agents, there is less likelihood of the use of biological warfare on a wholesale basis against a nation, and more chance of limited employment on population concentrations —perhaps by covert delivery, since shelters with adequate filtering could insure rather complete protection to those inside.

Chemical Weapons

Chemical weapons, like biological weapons, are relatively inexpensive to create, but face nearly insurmountable logistics problems on delivery. Although chemical agents produce casualties more rapidly, the greater amounts of material to deliver seriously limit the likelihood of their large-scale deployment. Furthermore, chemical research does not hold promise of the development of significantly more toxic chemicals for future use.

Radiological Weapons

The advantages of such modifications are much less real than apparent. In all weapons delivered by missiles, minimizing the payload and total weight is very important. If the total payload is not to be increased, then the inclusion of inert material to be activated by neutrons must lead to reductions in the explosive yield. If all the weight is devoted to nuclear explosives, then more fission-fragment activity can be created, and it is the net difference in activity that must be balanced against the loss of explosive yield. As it turns out, a fission explosion is a most efficient generator of activity, and greater total doses are not achieved by injecting special inert materials to be activated.

Perret, W.R., Ground Motion Studies at High Incident Overpressure, The Sandia Corporation, Operation PLUMBBOB, WT-1405, for Defense Atomic Support Agency Field Command, June 1960.

The Neutron Bomb

The neutron bomb, so called because of the deliberate effort to maximize the effectiveness of the neutrons, would necessarily be limited to rather small yields—yields at which the neutron absorption in air does not reduce the doses to a point at which blast and thermal effects are dominant. The use of small yields against large-area targets again runs into the delivery problems faced by chemical agents and explosives, and larger yields in fewer packages pose a less stringent problem for delivery systems in most applications. In the unlikely event that an enemy desired to minimize blast and thermal damage and to create little local fallout but still kill the populace, it would be necessary to use large numbers of carefully placed neutron-producing weapons burst high enough to avoid blast damage on the ground, but low enough to get the neutrons down. In this case, however, adequate radiation shielding for the people would leave the city unscathed and demonstrate the attack to be futile.

The thermal radiation from a surface burst is expected to be less than half of that from an air burst, both because the radiating fireball surface is truncated and because the hot interior is partially quenched by the megatons of injected crater material.

SUPERSEISMIC GROUND-SHOCK MAXIMA (AT 5-FT DEPTH)

Vertical acceleration: $\alpha_{vm} \simeq 340\, \Delta P_s / C_L$ ± 30 per cent. Here acceleration is measured in g's and overpressure (ΔP_s) in pounds per square inch. An empirical refinement requires C_L to be defined as the seismic velocity (in feet per second) for rock, but as three fourths of the seismic velocity for soil.

OUTRUNNING GROUND-SHOCK MAXIMA (AT ~10-FT DEPTH)

Vertical acceleration: $\alpha_{vm} \simeq 2 \times 10^5 / C_L r^2$ + factor 4 or -factor 2. Acceleration is measured in g's, and r is the scaled radial distance—i.e., $r = R/W^{1/3}$ kft/(mt)$^{1/3}$.

Data taken on a low air-burst shot in Nevada indicate an exponential decay of maximum displacement with depth. For the particular case of a burst of ~ 40 kt at 700 ft, some measurements were made as deep as 200 ft below the surface of Frenchman Flat, a dry lake bed, which led to the following approximate decay law, according to Perret.

$$\delta = \delta_0 \exp(-0.017D),$$

where δ represents the maximum vertical displacement induced at depth D, δ_0 is the maximum displacement at the surface, and D is the depth in feet.

Foreword

If the country were ever faced with an immediate threat of nuclear war, a copy of this booklet would be distributed to every household as part of a public information campaign which would include announcements on television and radio and in the press. The booklet has been designed for free and general distribution in that event. It is being placed on sale now for those who wish to know what they would be advised to do at such a time.

May 1980

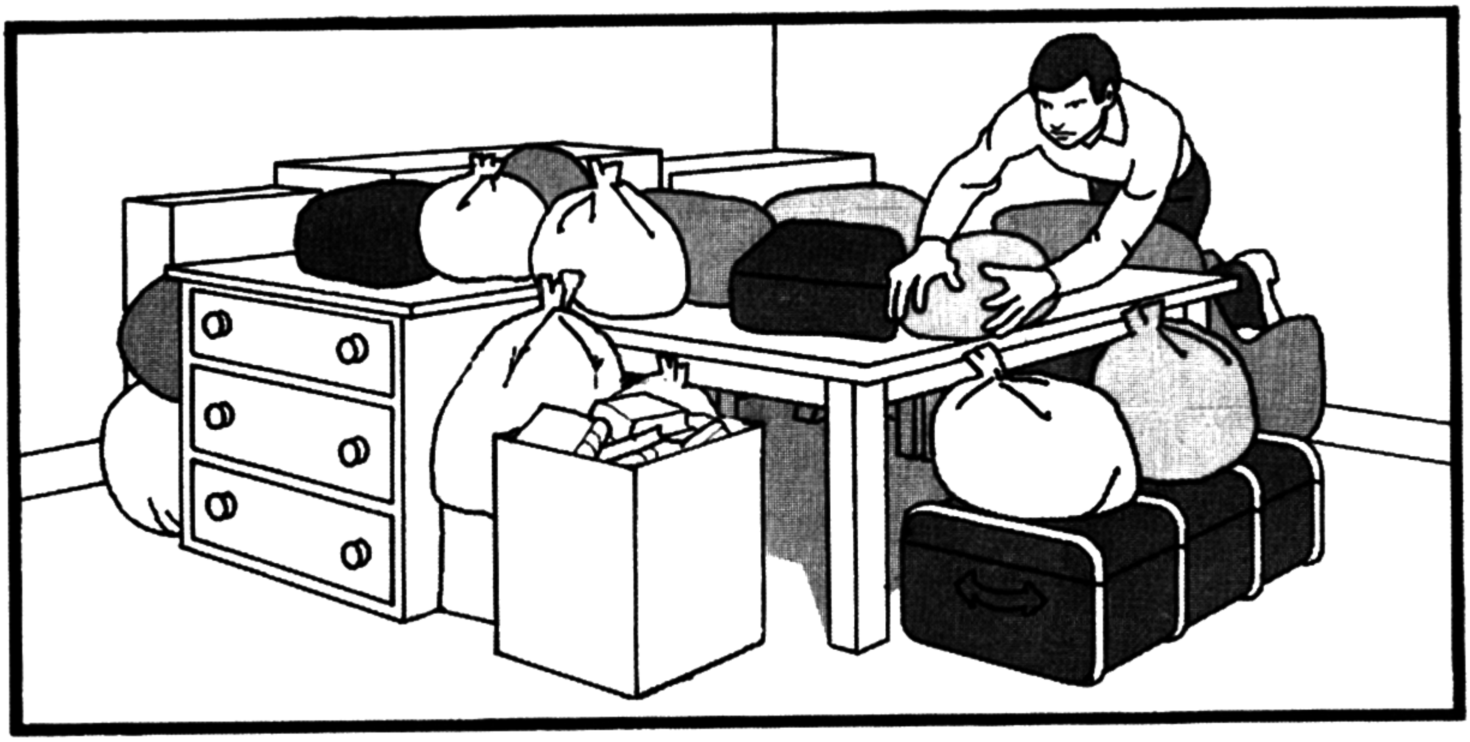
Protect and Survive
ISBN 0 11 3407289

If Britain is attacked by nuclear bombs or by missiles, we do not know what targets will be chosen or how severe the assault will be.

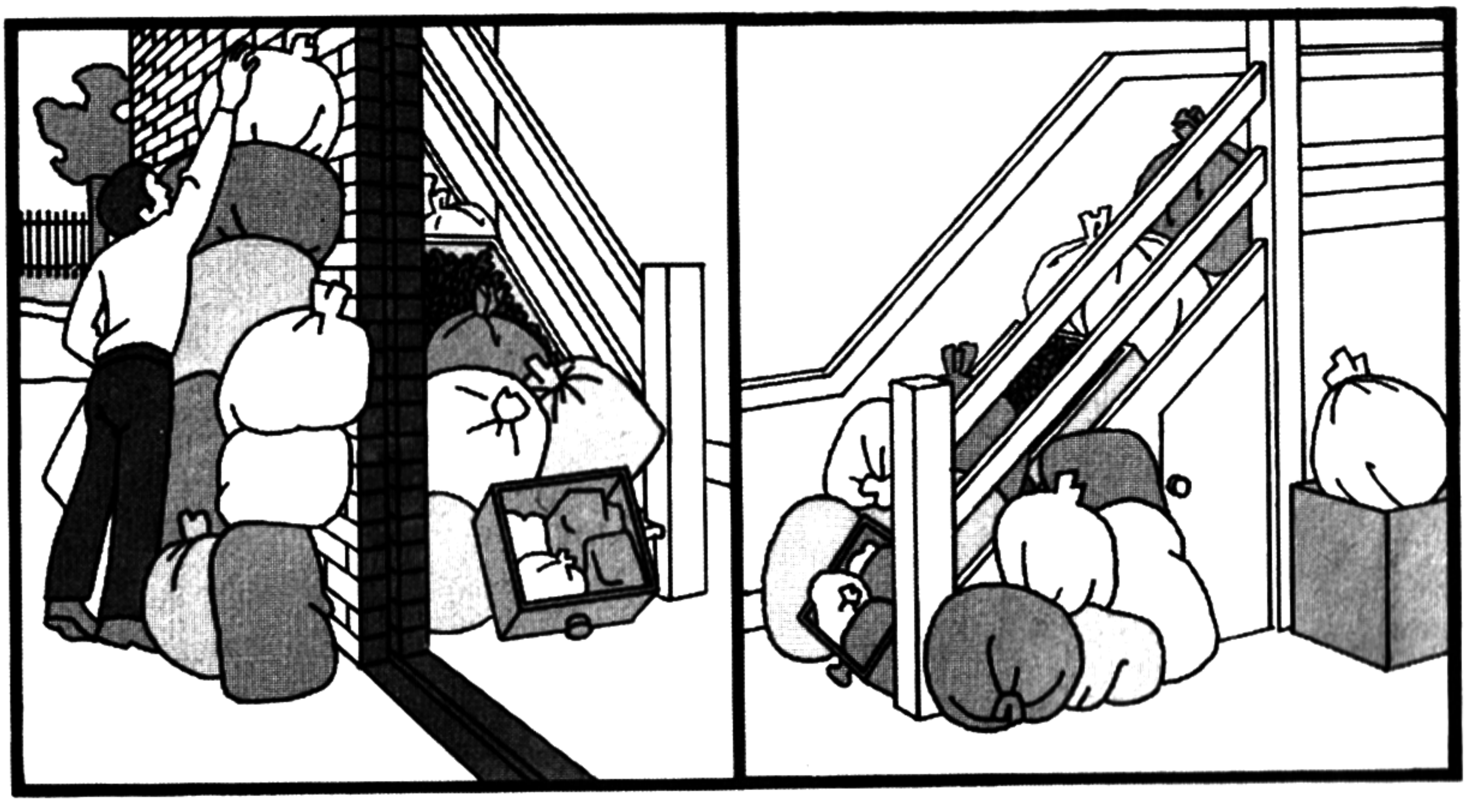
If nuclear weapons are used on a large scale, those of us living in the country areas might be exposed to as great a risk as those in the towns. The radioactive dust, falling where the wind blows it, will bring the most widespread dangers of all. No part of the United Kingdom can be considered safe from both the direct effects of the weapons and the resultant fall-out.

The dangers which you and your family will face in this situation can be reduced if you do as this booklet describes.

Use tables if they are large enough to provide you all with shelter. Surround them and cover them with heavy furniture filled with sand, earth, books or clothing.



Use the cupboard under the stairs if it is in your fall-out room. Put bags of earth or sand on the stairs and along the wall of the cupboard. If the stairs are on an outside wall, strengthen the wall outside in the same way to a height of six feet.



What to do after the Attack:

After a nuclear attack, there will be a short period before fall-out starts to descend. Use this time to do essential tasks. This is what you should do.

Do not smoke.

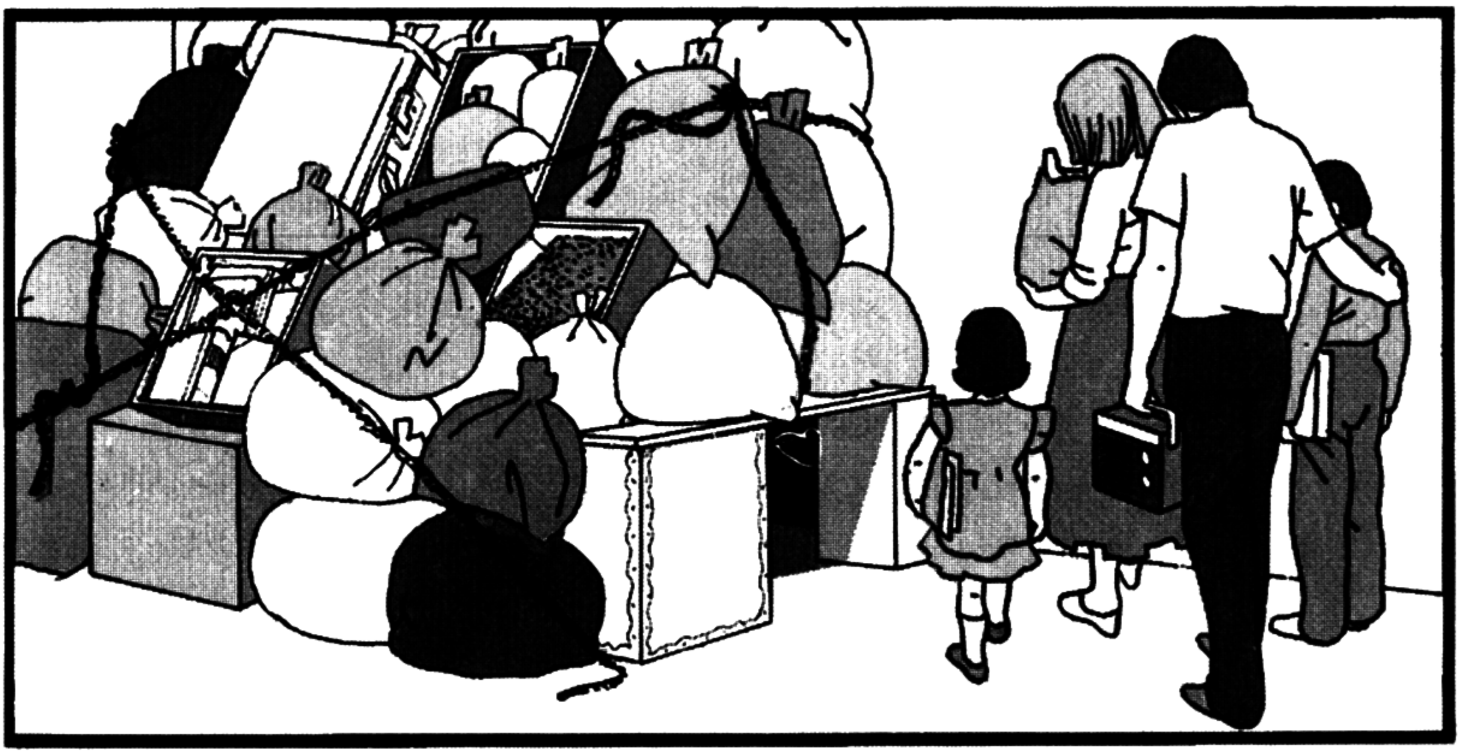
Check that gas, electricity and other fuel supplies and all pilot lights *are* turned off.

Go round the house and put out any small fires using mains water if you can.

If anyone's clothing catches fire, lay them on the floor and roll them in a blanket, rug or thick coat.

If there is structural damage from the attack you may have some time before a fall-out warning to do minor jobs to keep out the weather – using curtains or sheets to cover broken windows or holes.

If you are out of doors, take the nearest and best available cover as quickly as possible, wiping all the dust you can from your skin and clothing at the entrance to the building in which you shelter.



SEPTEMBER 1964

HOME OFFICE

CD/SA 121

SCIENTIFIC ADVISER'S BRANCH

IGNITION AND FIRE SPREAD IN URBAN AREAS FOLLOWING A NUCLEAR ATTACK

G. R. Stanbury

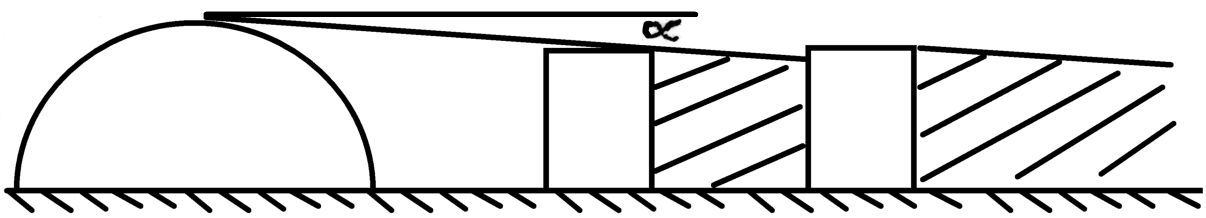
INITIAL FIRE INCIDENCE

For a 1 MT groundburst bomb the height of the top of the fireball above ground is about 0.72 miles. Because this distance is large compared with the height of most buildings, the exposed upper floors do actually see a large part of the fireball and not just the top of it, but in assuming that the radiation is just as intense from the top as from the middle we were overestimating the fire risk.

On the above basis the following table gives the number of exposed upper floors (to the nearest $\frac{1}{2}$ floor) for a range of distances from the explosion and a range of street widths.

Effect of Shielding: Estimation of the number of exposed floors

Assuming that buildings on opposite sides of a street which is receiving heat radiation from a direction perpendicular to its length are of the same height



Distance from explosion miles	Angle of arrival α^o	tan α	Width of street (units of 10 ft.)						
			2	3	4	5	6	7	8
1	35	.72	1.5	2	3	3.5	4.5	5	6
$1\frac{1}{2}$	26	.48	1	1.5	2	2.5	3	3.5	4
2	20	.36	.5	1	1.5	2	2	2.5	3
3	$13\frac{1}{2}$	.24	.5	.5	1	1	1.5	1.5	2
4	10	.18	.5	.5	.5	1	1	1.5	1.5
5	8	.15	.5	.5	.5	.5	1	1	1

we take the average depth of a floor to be 10 ft.

Angle between heat flash and street (degrees)	90-75	75-60	60-45	45-30	30-15	15-0
Proportion of heat flash entering windows %	99	92.5	80	60	40	14

SPREAD OF FIRE

From last war experience of mass fire raids in Germany it was concluded that the overall spread factor was about 2; i.e. about twice as many buildings were destroyed by fire as were actually set alight by incendiary bombs

Number of fires started per square mile in the fire-storm raid on Hamburg, 27th/28th July, 1943

Bombs dropped

102 tons H.E.

88 tons I.B.

48 tons, 4 lb. magnesium

40 tons, 30 lb. gel.

27,000 bombs

3,000 bombs

8,000 bombs on buildings

900 bombs on buildings

1,600 fires

800 fires

100 fires

2,500 fires in 6,000 buildings

However, the important thing to note is that the total number of fires started in each square mile (2,500) was nearly half that of the total number of buildings; in other words, almost every other building was set on fire during the raid itself. When this happened no fire-fighting organisation, however efficient could hope to prevent the fires from joining together and engulfing the whole area.

When the figure of 1 in 2 for the German fire storms is compared with the figures for initial fire incidence of $\sim$ 1 in 15 to 30 obtained in the Birmingham and Liverpool studies it can only be concluded that a nuclear explosion could not possibly produce a fire storm.

Fire situation from 1,499 fly bombs in the built-up part of the London Region

WWII V1 high explosives (1 ton TNT warhead) (cruise missiles)

Where dropped	Number of fly bombs	Fly Bombs Caused				
		No fire	Small fire	Medium fire	Serious fire	Major fire
City	119 ~~199~~	47	49	17	4	2
West-End	33	8	22	2	-	1
Closed Residential	430	207	203	20	-	-
Open Residential	804	478	296	28	2	-
Docks	113	64	39	8	1	1
Grand Totals	1,499	804	609	75	7	4

Discussion of results

Two important points emerge from a study of these results:-

(i) The small proportion of fly bombs - less than 20% - which started fires of any greater category than "small" even in the most heavily built-up areas; and

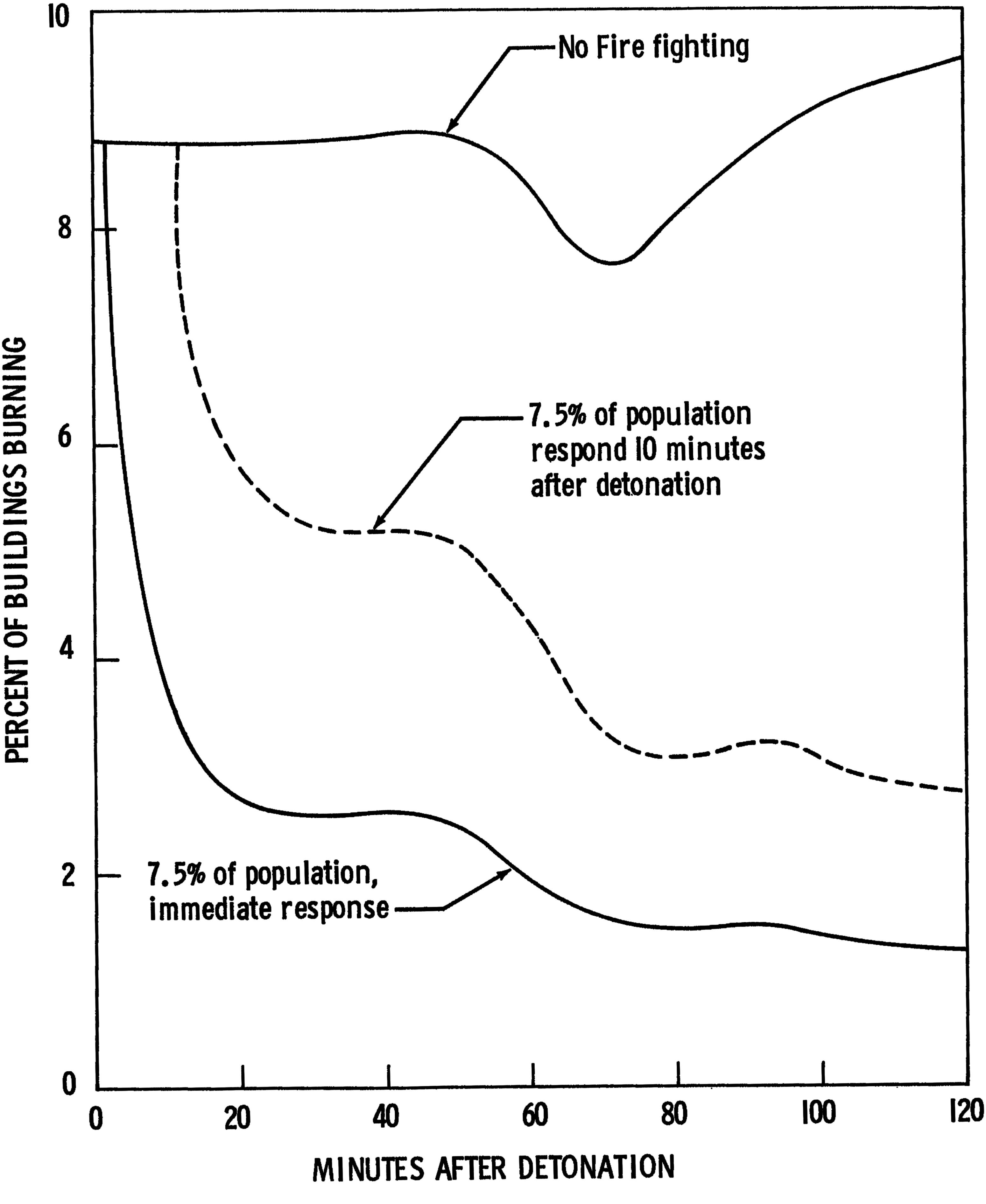
(ii) The large proportion which started no fires at all even in the most heavily built-up areas.

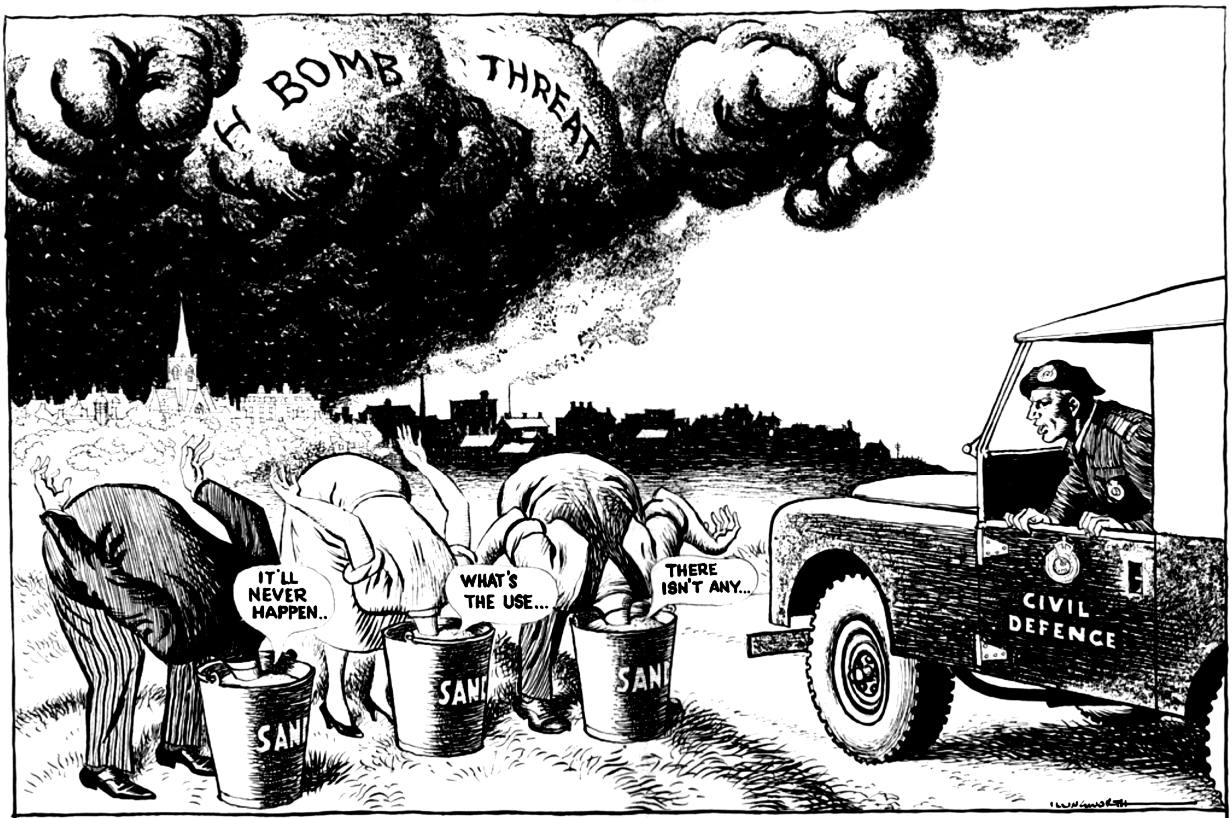
All these fly bombs fell in the summer months of 1944 which were unusually dry. In winter in this country in residential areas there are many open fires which may provide extra sources of ignition. The domestic occupancy is a low fire risk however, and as the proportion of such property in the important City and West End areas is small this should not introduce any serious error. Moreover, in winter, the high atmospheric humidity and the correspondingly high moisture content of timber would tend to retard or even prevent the growth of fire.

In order to determine how many fly bombs are equivalent to one nominal atomic bomb one method is to compare the areas over which a given category of house damage is produced by each. If we do this for a $\frac{3}{8}$th mile air burst as at Hiroshima, the result is that 1 atomic bomb does as much damage as about 1,200 fly bombs.

This in itself is not a serious fire situation and it is doubtful whether it could ever give rise to a fire storm. In Hamburg 2,500 fires were started per square mile by a bomb density (combined H.E. and I.B.) of 2oo tons per square mile, and for the area of destruction produced by an atomic bomb this would correspond to a total of about 10,000 fires.

Takata, A.N., **Mathematical Modeling of Fire Detenses, IITRI, March 1970, AD 705 388.**





IF YOU THINK IT'S HOPELESS, YOU'RE WRONG

Specially drawn for H.M. Government by Illingworth

Cartoon by Leslie Illingworth

FOUR STRAIGHTFORWARD SIMPLE FACTS ABOUT

Civil Defence Today

The basic minimum of information for every responsible man and woman

1 The H-Bomb: we hear too much of the horrors, not enough about our chances of survival. Some people will tell you that if this country were attacked with H-Bombs, every man jack of the population would be wiped out. ***That just isn't true: it isn't anything LIKE the truth.***

There would be terrible devastation, but for millions and millions of people, chances of survival would be very good. It depends very much on our Civil Defence. The more people we have in it, the better.

2 Civil Defence is well on with the job already. Some people think of Civil Defence equipment as a long-handled shovel, a rather odd tin hat, and so on.

Well, it's not like that at all. Civil Defence today is a modern, country-wide Service, which offers you training with first-class equipment—radio and radiation-testing instruments, fire-fighting apparatus and rescue gear, and the latest four-wheel-drive vehicles. There are thousands of qualified Instructors, three full-time Instructors' Schools, and a Staff College for advanced courses and studies.

The more you get to know about Civil Defence, the more impressed you become.

There is a Civil Defence organisation in every town in the Kingdom, and there are units in thousands of industrial firms. There are *half a million* people in the Civil Defence Services today. But half a million is not enough: not nearly.

3 Civil Defence is useful to you now, in peace. In Civil Defence today, you *learn*. That is the whole aim and object of joining.

You learn, first and foremost, how to live with your eyes open in the same world as the H-Bomb. You begin to learn what this new, nuclear-age world is really like. You acquire a fuller, deeper understanding of many important events that we are all involved in, whether we like it or not.

Besides this, there is a practical, everyday value in the things you learn. Take just one part of it—First Aid. In Great Britain in 1956 there were over *a quarter of a million* casualties from motor accidents, and probably at least another *million* casualties from accidents in the home. What you know—or don't know—about First Aid could make all the difference to somebody.

Do you know how to put out a fire? Do you know how to operate a radio transmitter? These are two more of the useful, interesting things that Civil Defence could teach you, now.

Do you remember the East Coast floods, the Lynmouth disaster, the Harrow rail smash? These are three of the emergencies where trained volunteers from Civil Defence were ready and able to help. They were needed.

4 Civil Defence wants more volunteers, NOW. It's no good saying "I'll be there on the day." That's too late. There wouldn't be time to train you and organise you.

It's no good leaving Civil Defence to other people. For everybody else, *The Other Fellow is YOU.*

You live in this world, you are part of the nuclear-age—there is no opting-out for anybody. Civil Defence *matters*—and matters to YOU.

Go along to your Council Offices today, and ask about Civil Defence. There's no commitment, no 'bull', no length-of-service engagements.

Your training takes only about *one hour a week*. The classes are free, and are near your own home. The knowledge you gain could be useful to you at any time, and would be VITAL to you if we were at War.

Civil Defence is sound common sense. It's high time you were in it.


Warden Section


Headquarters Section


Ambulance and Casualty Collecting Section


Welfare Section

The FOURTH Arm

Traditionally, we have three Services in this country: the Royal Navy, the Army, and the Royal Air Force. Now, we have a fourth service of the Crown—unarmed, volunteer, part-time—but not less vital than the others: Civil Defence. We have peacetime Civil Defence for just the same reasons that we have a peacetime Navy, Army and Air Force: it is an essential part of our ordinary peacetime national preparedness. *That is all there is to it.*

WHAT YOU CAN DO IN CIVIL DEFENCE

Five Sections: *which will you join?*

WARDEN. This is a job for a man or woman with a quick, cool head and the power of leadership—and something of a flair for getting on with people. The Warden takes control of the area in an emergency and directs the other services where they are required.

HEADQUARTERS. This is the nerve-centre, where the reports come in and the orders go out. If you are an office or scientific worker, a radio 'ham', motor-cyclist or driver—here is interesting, important work that you could train for now.

RESCUE. Members of Rescue Squads are highly skilled. Each man carries a pack containing saw, wrecking-bar, lashings, wire-cutters and First Aid kit—and he is trained in the use of all of them. Backing up the Rescue Squad is a special Rescue Vehicle, with scaffold-poles, cables, winches, stretchers and heavy rescue gear. A rescue man needs intelligence as well as strength.

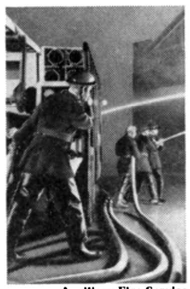
The **AMBULANCE AND CASUALTY COLLECTING** Section want two sorts of people—casualty collectors, to give First Aid and see that the injured get back safely to the ambulances—and drivers to take the ambulances back to hospital. This is work for both men and women—and if you drive a car already, so much the better.

The **WELFARE** Section would be called on first to help in bringing care and comfort to some millions of evacuees. But that is only the beginning of their job. After an attack, there would be more millions of people, to be housed, clothed, fed and kept healthy. Our very survival could depend on what the Welfare Section did then. The Welfare Section needs dependable, intelligent, capable men and women; and it needs them now.

AND THE AUXILIARY FIRE SERVICE, which also has really worth-while, practical training to offer. The work is important; a nuclear explosion sends out an intense heat-wave, and fires would be numerous and quick to spread. The A.F.S. has special nuclear-war fire-fighting apparatus: you would do your training with it.

IN EVERY SECTION YOU GET FIRST AID TRAINING


Rescue Section


Auxiliary Fire Service

Civil Defence Recruiting Drives are going on now, all over the country. Their object is to tell you all about Civil Defence — what it can do, what it IS doing and what there is in it for you.

CIVIL DEFENCE is common sense

Go to your Council Offices and ask, today. They will be glad to see you.

ISSUED FOR H.M. GOVERNMENT BY THE CENTRAL OFFICE OF INFORMATION

UK National Archives: INF 2/122

September 1957 national press advert

THE Hydrogen Bomb

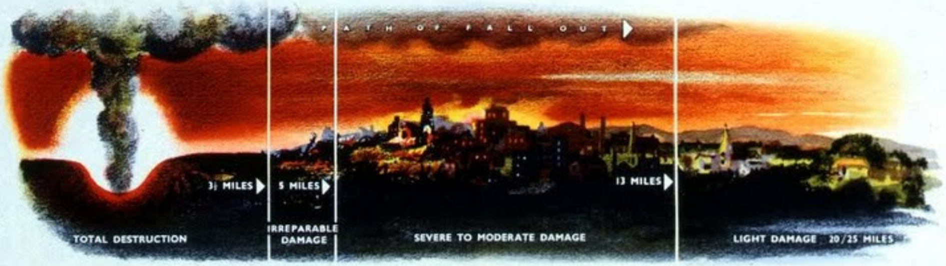
WHAT THE HYDROGEN BOMB DOES

The hydrogen bomb's power is reckoned in millions of tons of high explosive; its searing fireball, white and blinding, is as hot as the sun's interior. It can gouge a crater in the earth a mile wide and up to 200 feet deep; and its dust can cause death or sickness hundreds of miles away if proper precautions are not taken. The menace is threefold, for the hydrogen bomb strikes with heat, blast and deadly radiation.

HEAT from the fireball, a mile-and-a-half across, instantly vaporizes anything it touches before it soars into the upper skies. Fiercest during the first ten seconds, its rays can burn exposed skin or set fire to houses as far away as 10 to 15 miles. They can still be felt at 50 miles.

BLAST surges outwards at the speed of sound, accompanied by a hurricane wind. It enters doors and windows, causing buildings to "explode". It tilts or overthrows walls in its path. An overhead burst crushes roofs through their supporting walls. The worst danger is that people might be struck by flying wreckage, or hurled to the ground or against walls or other objects. Light damage from an air burst could be found as far as 20 to 25 miles from the centre of the explosion, and windows would be broken even farther away.

RADIATION The rising fireball sucks up and contaminates debris and dust and this is carried downwind to drift slowly back to earth as "fall-out". There it continues to give out dangerous radiation. Radiation is particularly dangerous because it cannot be felt or smelled, tasted, heard or seen. It can be detected and measured only with sensitive instruments. Even if you kept all the fall-out dust off you, you might still be injured, if you stayed in the open, by radiation from fall-out many yards away.



What YOU could do

Simple precautions which you and your family could take against heat, blast and radiation could save your lives. Heat and blast are familiar from the last war. Radiation is new, and only a thick shield of metal, masonry, earth or other heavy matter will protect you against it. Used to the best advantage, an ordinary house with 9-inch brick walls should reduce the danger from radiation to one-twentieth. Here are some things you could do if war looked likely:

Site a refuge in basement or cellar, or in the ground floor room with the fewest outside walls. Thicken the walls with sandbags or even heavy furniture. Block the windows. Equip the refuge with essentials, including chairs and couches, books and a battery-run radio. Store an ample supply of food and water.

Alternatively, dig an outside trench, cover it with a strong roof, pile two or three feet of earth on top. Equip it like an indoor shelter if possible. A trench may be less comfortable than an indoor shelter but there is no risk from collapsing upper floors and walls. Whether in trench or indoors, obey radio instructions. Because of fall-out you might have to remain two or more days under cover.

It is the contents of a house which catch fire, and not the bricks and mortar. So keep out as much of the heat flash as possible.

Remove curtains, furniture and anything inflammable from windows and doorways.

Whitewash the window-panes. This will block most of the heat, which will be largely over before the blast catches up to shatter the glass.

WHAT YOU CAN DO NOW Join the Civil Defence Corps or the Auxiliary Fire Service. They will teach you how to help yourself and others if war should come.

APPLY TO YOUR LOCAL COUNCIL OFFICES

PREPARED FOR THE HOME OFFICE BY THE CENTRAL OFFICE OF INFORMATION

The photograph shows Britain's nuclear test explosion at Christmas Island on 15 May, 1957. The soaring mushroom, now well developed, has pierced the local natural cloud.

What CIVIL DEFENCE can do!

There is no absolute safeguard against an H-bomb attack. Nothing could stop widespread casualties and devastation. But life would go on. It would be disrupted and distorted, with many familiar services lacking or severely cut, but that would not mean an end to everything – not by any means. Millions of people would survive to carry on. How many, and how far they succeeded, would largely depend on their knowledge of what to do as a nation and as individuals before and after the bombs struck.

Civil Defence, the part-time, volunteer Fourth Arm of our defence services, is being trained to act in an H-bomb emergency. Established throughout Britain, its members would spring to action in the stricken areas. Civil Defence is organised and trained to allay panic, aid the injured, trapped and homeless, and help to establish order and maintain the nation's life.

The Civil Defence Corps and its allied services each have specialised jobs as well as general duties.

THE HEADQUARTERS SECTION

Controls operations, provides scientific intelligence, establishes "fall-out" danger zones, arranges communications.

THE WARDEN SECTION

Provides the men, cool-headed and resourceful, who are the link between civil defence and the public and direct the other services where they are most needed.

THE RESCUE SECTION

Using specialist equipment, frees people trapped under wreckage or in shattered buildings. Duties may range from demolition work to providing first aid.

THE WELFARE SECTION

Houses, feeds and cares for the homeless and hungry.

THE AMBULANCE & CASUALTY COLLECTING SECTION

gives first aid, gets the casualties to the ambulances, and takes them to hospital.

The Fire, Police, Nursing and other allied Services, with their normal duties doubled by an emergency, link with the Civil Defence Corps in carrying out the plan for survival.

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HOME OFFICE

CIVIL DEFENCE

Manual of Basic Training

VOLUME II

ATOMIC WARFARE

PAMPHLET No. 6

(Based on survival in Hiroshima

and Nagasaki after 20 kt bursts)

LONDON: HIS MAJESTY'S STATIONERY OFFICE
1950

TWO SHILLINGS NET

FOREWORD BY THE PRIME MINISTER

The object of this pamphlet is to provide all members of the Civil Defence Corps and other Services associated with Civil Defence with a short manual of practical information about the atomic bomb and its effects. It is, of course, our earnest hope that we shall never have to experience the horrors of an atomic attack. The tremendous force of atomic power should be used for industrial and humanitarian purposes and not for mass destruction. Ever since the Washington Declaration, which I signed with the President of the United States and the Prime Minister of Canada in November 1945, the United Kingdom has pressed for international agreement to ensure that atomic energy should be used only for peaceful purposes. But any such agreement would be illusory without the most rigorous system of international control. Although nearly two years ago nine out of the eleven members of the United Nations Atomic Energy Commission agreed on what they considered to be a really effective plan for the control of atomic energy and although this plan was subsequently approved by the overwhelming majority of the General Assembly of the United Nations, the Soviet Union has so far refused to accept it, and has instead put forward counter-proposals which were rejected in the Commission by a nine to two vote on the ground that they did not provide an adequate basis for effective international control. We shall not, however, abandon our hope that an effective system of international control may ultimately be adopted by the United Nations, and we for our part will certainly do all in our power to make such an agreement possible. In the meantime we must proceed with our Civil Defence preparations on the basis that, in the event of war, we might be subjected to atomic attack and with the object of minimising the casualties which must inevitably accompany such an attack.

June, 1950.

C R Attlee

CONTENTS

NOTE

The pagination of this pamphlet is not continuous as it may be necessary to introduce new pages at a later date.

Photo No. 18. NAGASAKI. Typical small earth-covered back yard shelter with crude wooden frame, less than 100 yds. from the centre of damage, which is to the right. There was a large number of such shelters, but whereas nearly all those as close as this one had their roofs forced in, only half were damaged at 300 yds., and practically none at half a mile from the centre of damage.

Debunking impulse blast criteria:

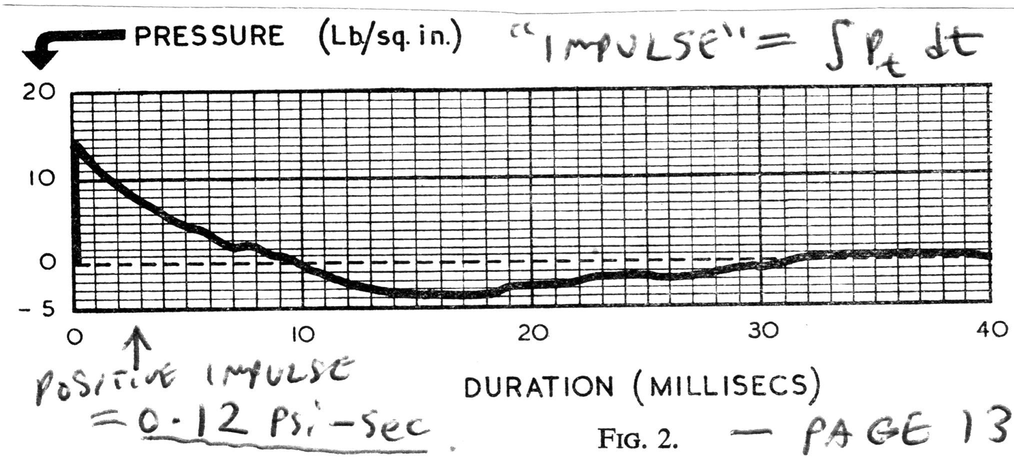


FIG. 2. — PAGE 13.

Figure 2 shows a typical pressure-time curve from a medium sized high explosive bomb at a distance at which fairly severe structural damage would be caused. **- page 11**

If the impulse criterion were applied to the atomic bomb it would be expected to demolish 9-inch brick walls to a distance of over 10 miles. However, at this distance from the atomic bomb the peak pressure is only about 0.1 lb./sq. in. which is very much less than the static strength of the wall, and consequently, however long this pressure is applied, it cannot hurt the wall. It will thus be seen that the impulse criterion breaks down for the atomic bomb. The position is that the blast impulse is only the criterion of damage so long as the maximum blast pressure is substantially greater than the static strength of the target, and this is not the case at the limits of damage to normal structures with an atomic bomb. With the atomic bomb, therefore, blast pressure rather than impulse tends to be the criterion of damage. If the effective blast pressure exceeds the static strength of the structure failure must be expected, whereas if it is less no failure can occur however long the duration of the blast. **- page 12** **(debunks American propaganda!**

Photo No. 7. HIROSHIMA. Reinforced concrete building about 300 yds. from the centre of damage, which is to the left of the photograph. There was no serious structural damage, although a roof panel was depressed and some internal party walls were deflected. Designed for earthquake resistance, this building has a composite reinforced concrete and steel frame.

SIMPLE WALL SURVIVING CLOSE TO GROUND ZERO.

Photos Nos. 1 and 2. HIROSHIMA. General views looking across the centre of damage, the approximate position of which is marked with an arrow. It will be seen that some of the framed buildings quite near the centre remained standing. The tall building in Photo No. 1 is the same as that seen in Photo No. 7. The foreground illustrates the remnants of Japanese dwellings, razed to the ground. =THE OBSOLETE WOODEN HOUSES BURNED DOWN.

Protection against blast would not present an insoluble problem. Japanese air raid shelters, even of poor construction, stood up well and underground shelters were a complete protection. Shelters could be constructed to resist both blast and gamma rays.

28. **Effects on Material** PAGE 39:

From air burst bombs the blast wave is from above downwards and strikes roofs first, and near the centre of the damaged area buildings are collapsed or, with specially strong buildings, roofs are crushed in or dished even where the walls remain standing. Further away, where the blast wave is becoming more horizontal, buildings are pushed over or distorted.

The type of building and the distance from ground zero are the factors influencing reaction to blast. Unframed buildings like ordinary dwelling houses suffer more severe damage than framed buildings, whether of reinforced concrete or steel, and buildings of earthquake-resisting construction remain practically undamaged at 2,000 feet from ground zero. Bridges, which are built to withstand vertical pressure, stand up to the blast much better than ordinary houses, which are not so constructed, though reflection from roads, rivers, etc., may cause displacement on the underside and is a point to be carefully watched.

The British Mission estimated that from a high air burst bomb such as was used in Japan, an ordinary British city with 15 houses and 45 persons to the acre would suffer damage to dwelling houses to a distance of 2 to 2½ miles from ground zero on the following scale:—

Nature of Damage	*Average Radius from Ground Zero and Number of Houses Involved*
Demolished or requiring demolition	1 mile 30,000 houses
Uninhabitable and requiring major repairs	1–1½ miles 35,000 houses

---

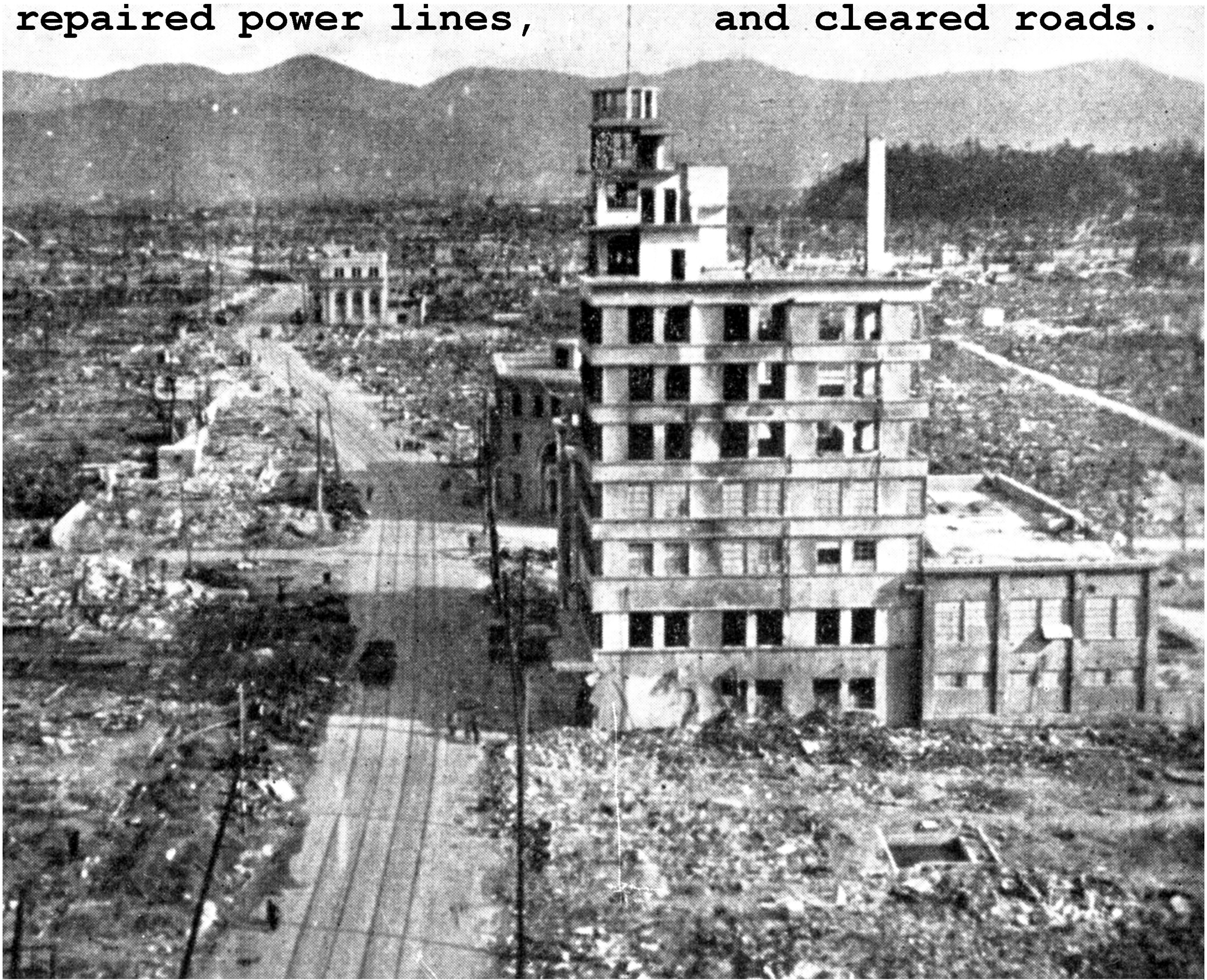
5. **Estimates of Casualties in a British City** — PAGE 13:

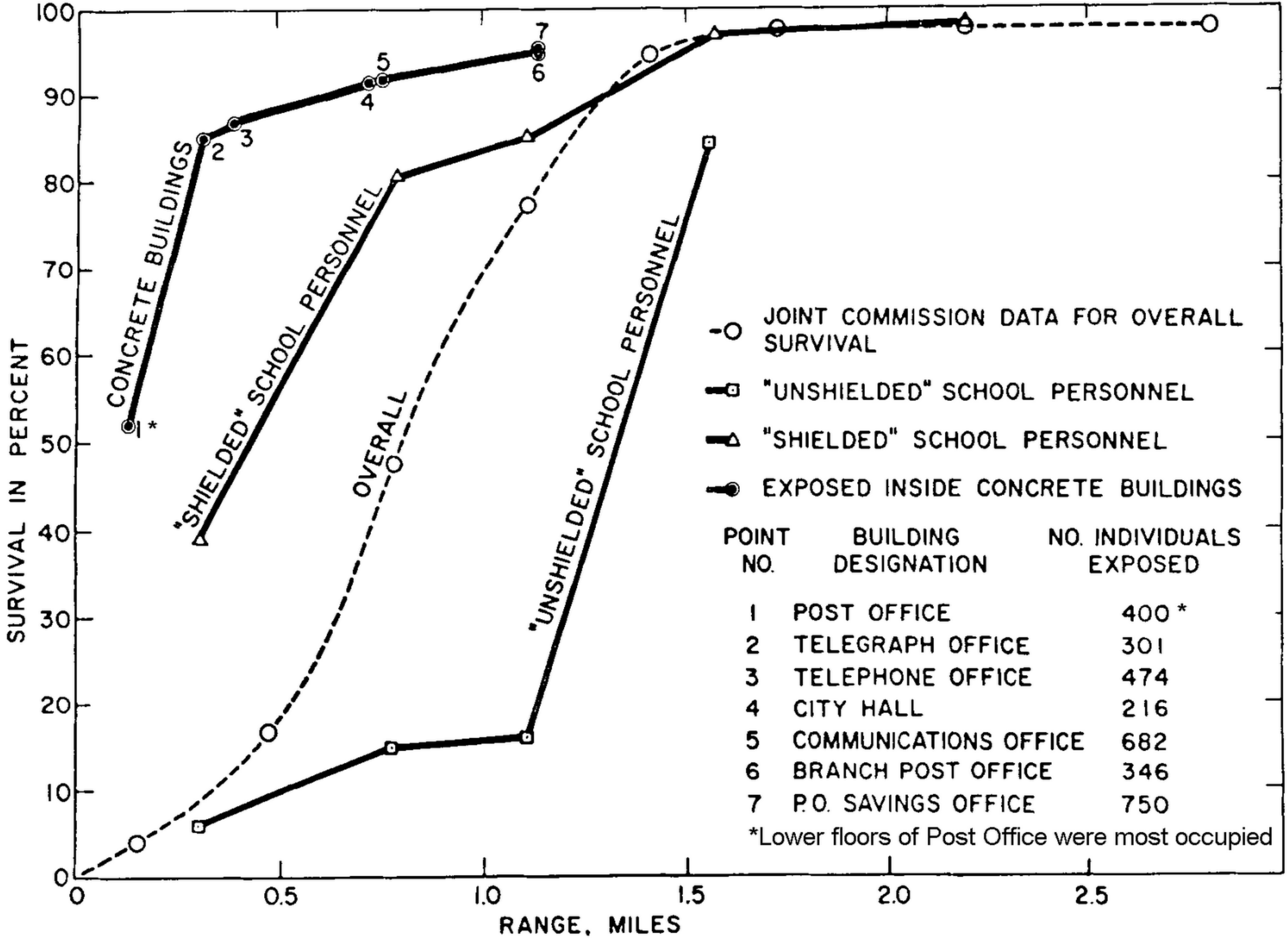
If the people in our cities were caught, as were the Japanese, without warning, before any evacuation had taken place, and with no suitable shelters, the casualties caused by a high air burst bomb would be formidable. The British Mission to Japan estimated that *under these circumstances* as many as 50,000 people might lose their lives in a typical British city with a population density of 45 persons to the acre. Much can be done, however, to mitigate the effects of the bomb and to save life, and it is certain that with adequate advance preparations, including the provision of suitable shelters and with good Civil Defence services, the lives lost could be reduced to a fraction of the number estimated by the British Mission.

The figures set out in the preceding paragraph are those given as an estimate by the British Mission from the experience of the high air burst bombs used in Japan and under similar conditions would apply to persons in a British city. *It must be stressed however that they apply to persons caught in the open with no warning or suitable shelter,* and that even ordinary houses will give some degree of protection by lessening the intensity of the rays that penetrate them. — PAGE 9.

Hiroshima at
2 days after burst

Hiroshima in November 1945: note boarded windows
repaired power lines, and cleared roads.





Percentage of survivors as a function of range from Ground Zero (Hiroshima). (Ref. Joint Commission Report, Vol. VI, Document NP-3041.)

SURVIVAL IN WOODEN AND CONCRETE BUILDINGS, HIROSHIMA

TABLE 7.3

Casualties among the Groups Exposed to the Atomic Bomb inside Wooden Houses, Hiroshima

Name of Building	Structure	Distance and Direction from Hypocenter (km)	Number Exposed	Mortality Rate (%)
Lodging for an itinerant theatrical troupe	Two-story	0.7 E	17	100.0
Second Hiroshima Army Hospital	Single-story	1.0 N	402	75.3

Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 25.

TABLE 7.4

Casualties among the Groups Exposed to the Atomic Bomb inside Concrete Buildings, Hiroshima

Name of Building	Structure	Direction and Distance from Hypocenter (km)	Number Exposed	Mortality Rate (%)
The Bank of Japan, Hiroshima Branch	three-story	0.4 SE	75	57.3
Broadcasting Station	two-story	1.0 E	31	6.5
Communication Bureau	four-story	1.4 N	245	6.1
Japan Red Cross Hospital, Hiroshima	three-story	2.0 S	480	0.4

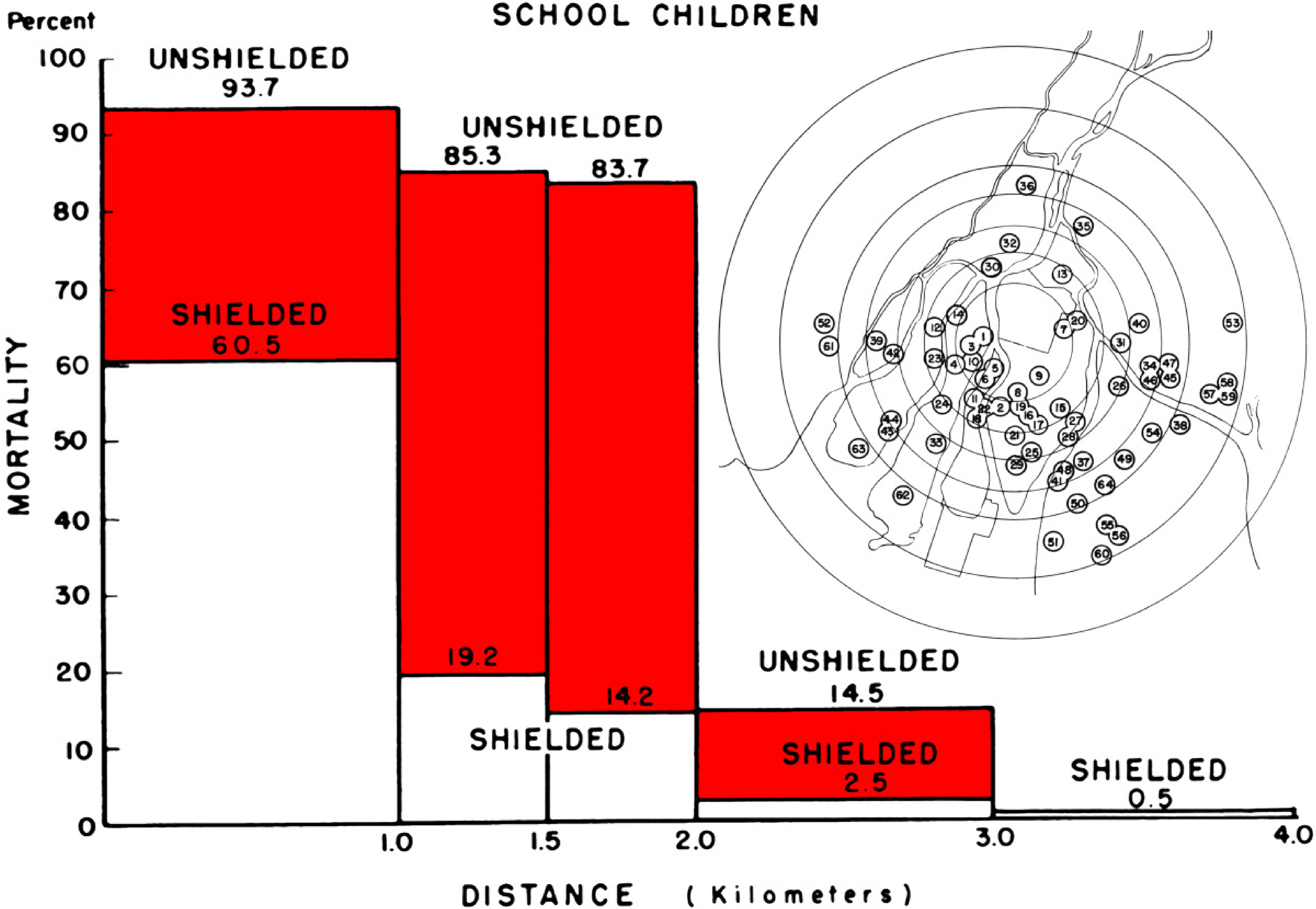
• While the total number of exposed is known, it has not been possible to determine how many died instantly or soon after the explosion.
Source: Science Council of Japan, *Genshibakudan Saigai Chōsa Hōkokusho* [SRIABC] (Tokyo: Nihon Gakujutsu Shinkōkai, 1951), p. 26.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981

THERMAL FLASH SHIELDING

HIROSHIMA
SCHOOL CHILDREN

NP-3041



In Hiroshima, only 0.9% (17 burns) of 1,881 burns were due to ignited clothing, and only 0.7% (15 burns) were due to burns by firestorm flames!

TABLE 8.3A

Number of Persons with Burns from Different Causes (Tokyo Imperial University's First Survey, October–November 1945)

Distance from Hypocenter (km)	Secondary Burns† From Clothes on Fire	Secondary Burns† By Flame	Total Burns
0.6–1.0	3 (3.3)		89
1.1–1.5		1 (1.1)	327
1.6–2.0	4 (0.5)	4 (1.2)	717
2.1–2.5		6 (0.8)	558
2.6–3.0	5 (0.8)	3 (0.5)	140
3.1–3.5	4 (2.8)	1 (0.7)	41
3.6–4.0	1 (2.4)		4
Total	17 (0.9)	15 (0.7)	1,881

* Primary burns are burns by thermal rays from the A-bomb.
† Secondary burns are burns by fire other than thermal rays.
‡ Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Note: there were 5 burns cases within 0.6 km, all primary

TABLE 8.3B

Region of Burns

	Head		Face		Neck		Total	
	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors	Outdoors	Indoors
Number of persons	179 (11.7)*	44 (12.3)	1,030 (67.4)	127 (35.7)	643 (42.1)	78 (21.9)	1,526	355
Total	223 (11.8)		1,157 (61.5)		721 (38.3)		1,881	

* Figures in parentheses are percentages of incidence.
Source: T. Kajitani and S. Hatano, "Medical survey on acute effects of atomic bomb in Hiroshima," in CRIABC vol. I, p. 522.

Above: extract from "Hiroshima and Nagasaki: The Physical, Social and Medical Effects", 1981 by the Japanese Committee for the Compilation of Materials on Damage Caused by Atomic Bombs

HIROSHIMA: Bankers Club, 250 m from GZ, view looking out from GZ.
Photograph date: 27 November 1945.

HIROSHIMA: Nippon Bank, 450 m from GZ, view from GZ. Photograph date: 27 November 1945.

HIROSHIMA: Telephone Exchange Building, 550 m from GZ, view from GZ
Photograph date: 27 November 1945

HIROSHIMA: Radio Broadcasting Studio, 900 m from GZ, view from GZ
Photograph date: 27 November 1945.

HIROSHIMA: City Hall, 1200 m from GZ, view from direction of GZ.
Photograph date: 27 November 1945.

HIROSHIMA: Red Cross Hospital, 1600 m (1 mile) from GZ,
view looking from the direction of GZ
Photograph date: 27 November 1945

HIROSHIMA: 26 October 1945

HIROSHIMA: 27 November 1945

SINGLE NON-NUCLEAR INCENDIARY AIR RAID: TOKYO, 10 MARCH 1945

AIR MINISTRY
AP 3349

RESTRICTED
The information given in this document is not to be communicated, either directly or indirectly, to the Press or to any person not authorized to receive it.

WO
CODE No.
9466

26/GS Trg Publications/2329

PRECAUTIONS AGAINST NUCLEAR ATTACK

1957

(Superseding Precautions Against Atomic Attack, 1952 (WO Code No. 8769))

Promulgated by Command of the Army Council,

E. W. Playfair

Promulgated by Command of the Air Council,

J. H. Barnes


Telegraph pole burnt on the side facing the flash. Note where foliage has acted as a shield


Shelter 100 yards from the centre of damage—Nagasaki

Protection against fall-out

101. Except in the immediate vicinity of a nuclear explosion a reasonably accurate prediction of the area of fall-out can be made in time for a warning to be issued to units in the areas in which it is likely to fall. Given a reasonable warning it may be possible to evacuate the area before the fall-out arrives. In any case simple precautionary measures can greatly reduce the hazard to life.

102. Exposure to the radio-active radiations from fall-out can be reduced by taking shelter and by using simple decontamination procedures until such time as persons can leave the area. In areas where radio-active contamination is heavy it may be necessary to remain under cover for as long as 48 hours before the radiations will have fallen, by natural decay, to levels at which it will be safe for persons to move about, either to leave the area, or, in the case of rescue teams from other areas, to enter it.

103. The estimated degree of protection against the residual radiation to be obtained from buildings, trenches, etc, in a fall-out area is shown at Table 7:—

TABLE 7. **Estimated degree of protection against the residual radiation to be obtained from various buildings, trenches, etc, in a fall-out area**

Type of building or shelter	INSIDE dose expressed as a fraction of the OUTSIDE dose	
Slit trench with light board or corrugated iron overhead	$\frac{1}{2}$	
Slit trench with 1 ft of earth overhead	$\frac{1}{100}$	
Slit trench with 2 ft to 3 ft of earth overhead	$\frac{1}{200}$ to $\frac{1}{300}$	
Nissen hut	$\frac{1}{2}$	
One storey brick house	$\frac{1}{10}$ to $\frac{1}{20}$	dependent upon wall thickness and shielding afforded by neighbouring houses
Two storey brick house	$\frac{1}{10}$ to $\frac{1}{50}$	
Three storey brick house	$\frac{1}{15}$ to $\frac{1}{100}$	
Average two storey house in a built up area	$\frac{1}{40}$	
Basements	$\frac{1}{200}$ to $\frac{1}{300}$	dependent upon shielding afforded by neighbouring houses

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14 PAGES

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AWRE – T1/53

Wdn. 22/10/84. SCO 468 refers

NATIONAL ARCHIVES
ES5/1

MINISTRY OF SUPPLY

ATOMIC WEAPONS RESEARCH ESTABLISHMENT

REPORT No. T 1/53
(HURRICANE)

B. 0134

DECLASSIFIED FOR PR…
BY AWE ALDERMASTON

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A.W.R.E.
Aldermaston Berks.

[redacted]

May, 1953

3.2 Blast Damage

Outdoor peak overpressure was 51 psi at 500 yds, 25 psi at 665 yds and 10 psi at 1,000 yds 3 psi extended to 2,000 yds

3.2.1 Anderson Shelters

Standard Anderson Shelters, with sandbag covering and blast wall construction were locat.;d at 460, 510, 600, 920 and 1,130 yards from ground zero. Mean blast pressures, in pounds/sq. inch, recorded inside the shelters are shown in the following table.

Distance (yds.)	Presentation		
	Front	Side	Rear
460	NR	NR	NR
510	38	27	40
600	28	21	28
920	16	7	14
1130	8.5	4	5.5

Front presentation implies blast wall facing towards event.
Rear " " " " " away from event.
Side " " shelter side on to event.

Shelters at 460, 510 and 600 yards suffered damage including demolition of blast walls, removal of sandbag covering and some displacement of the corrugated iron.

At 920 and 1,130 yards the shelters suffered relatively little damage.

Civil defence authorities consider that there might have been some 50% survival from blast damage of personnel in shelters at 460 yards and some 90 per cent at 600 yards, fatal casualties being mainly due to secondary blast effects (e.g. debris) and not to direct effects on the person of the blast pressure itself. The front presentation appears the most hazardous, due to the collapse of the blast wall into the shelter. At such distances, however, the survival from the effects of gamma flash would have been virtually nil. (MORE EARTH COVER IS NEEDED FOR RADIATION.)

At 920 and 1,130 yards there would have been no casualties from blast, and incidentally, little risk from the effect of gamma flash.



UK NATIONAL ARCHIVES: ES 5/2

ANDERSON SHELTER TESTS AGAINST 25 KT NUCLEAR NEAR SURFACE BURST (2.7 METRES DEPTH IN SHIP)

AWRE-T1/54, 27 Aug. 1954

SECRET—GUARD

ATOMIC WEAPONS RESEARCH ESTABLISHMENT

(formerly of Ministry of Supply)

SCIENTIFIC DATA OBTAINED AT OPERATION HURRICANE

(Monte Bello Islands, Australia—October, 1952)

$$p = \frac{130 \times 10^9}{R^3} + \frac{7 \cdot 7 \times 10^6}{R^2} + \frac{13 \cdot 5 \times 10^3}{R}$$

p is the maximum excess pressure in p.s.i. and R is the distance in feet

Fig. 12.1, Andersons at 1380 ft range from bomb ship shown in the photo, moored 400 yards off shore.

Left: Fig. 12.3, Andersons at 1800 ft after burst. Right: Fig. 12.4, Andersons protected by blast walls at 2760 ft.

12.1. *Blast Damage to Anderson Shelters*

At 1,380 feet, Fig. 12.1, parts of the main structure of the shelters facing towards and sideways to the explosion were blown in but the main structure of the one facing away from the explosion was intact, and would have given full protection. At 1,530 feet, Fig. 12.2, the front sheets of the shelter facing the explosion were blown into the shelter but otherwise the main structures were more or less undamaged, as were those at 1,800 feet, Fig. 12.3.

At 2,760 feet, Fig. 12.4, some of the sandbags covering the shelters were displaced and the blast walls were distorted whilst at 3,390 feet, Fig. 12.5, the effect was quite small. At these distances, the shelters were not in direct view of the explosion owing to intervening sandhills.

13. The Penetration of the Gamma Flash

13.1. *Experiments on the Protection from the Gamma Flash afforded by Slit Trenches*

13.1.1. The experiments described in this section show that slit trenches provide a considerable measure of protection from the gamma flash. From the point of view of Service and Civil Defence authorities this is one of the most important results of the trial.

13.1.2. Rectangular slit trenches 6 ft. by 2 ft. in plan and 6 ft. deep were placed at 733, 943 and 1,300 yards from the bomb and circular fox holes 2 ft. in radius and 6 ft. deep were placed at 943 and 1,300 yards.

The doses received from the flash were measured with film badges and quartz-fibre dosimeters in order to determine the variation of protection with distance, with depth and with orientation of the trench and the relative protection afforded by open and covered trenches.

In general, the slit trenches were placed broadside-on to the target vessel but at 1,300 yards one trench was placed end-on. Two trenches, one at 733 and one at 943 yards were covered with the equivalent of 11 inches of sand.

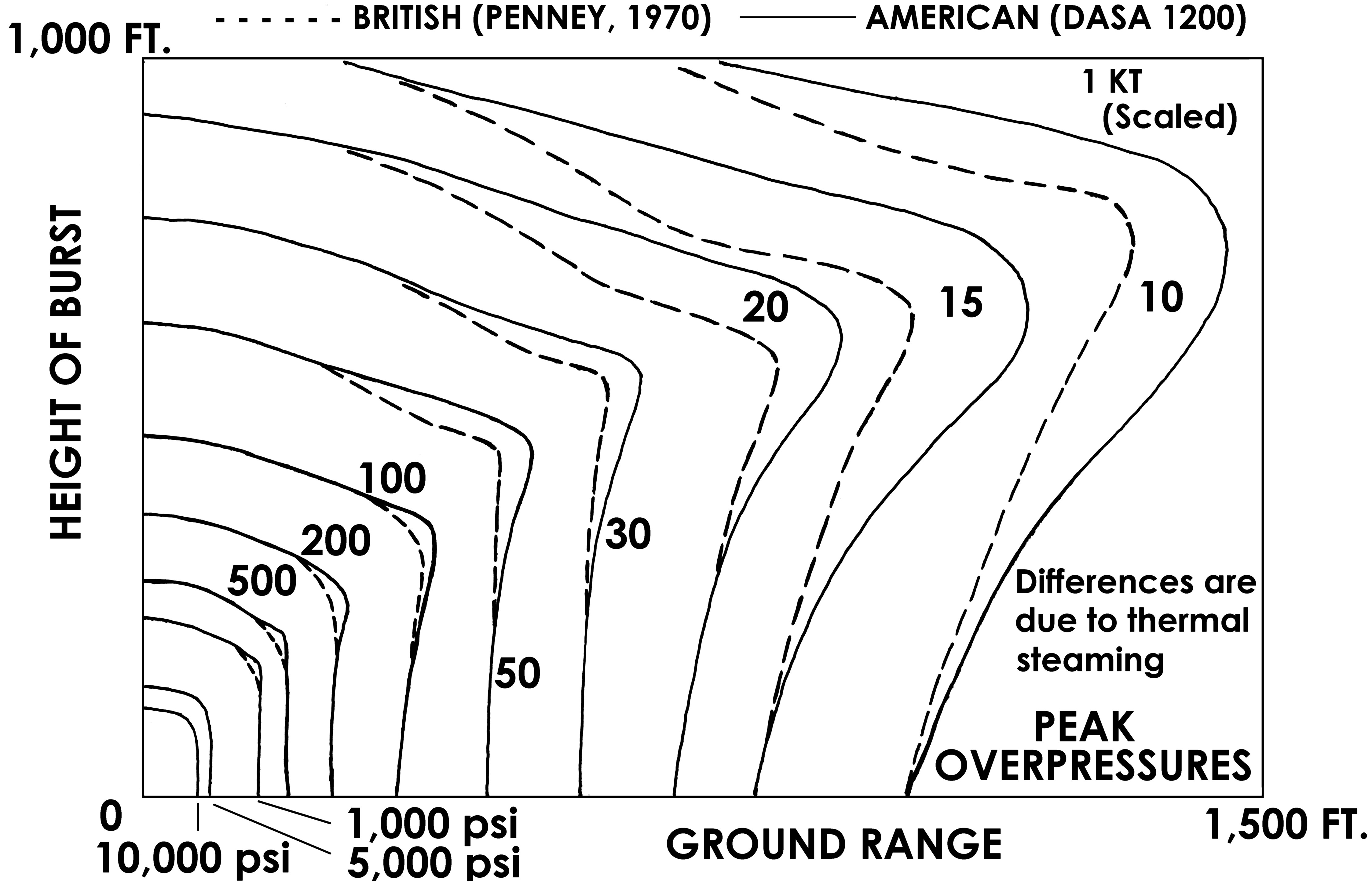
TABLE 13.1

Variation of Gamma Flash Dose on Vertical Axis of Trench

Type of trench	Rectangular broadside-on open			Rectangular end-on open	Circular open		Rectangular broadside-on covered	
Distance (yards) ...	1,300	943	733	1,300	1,300	943	943	733
Surface dose (Roentgens)	300	3,000	14,000	300	300	3,000	3,000	14,000
Depth below ground level (inches)								
6 ...	150	1,000	—	230	214	1,200	(75)	—
12 ...	75	430	—	150	120	545	47·6	—
24 ...	33·3	150	584	60	54·5	188	25	(140)
36 ...	23	70	216	31·6	30	86	13	(56)
48 ...	(20)	43	100	20	17·7	48·5	7·7	(31)
60 ...	—	(37·5)	61	13·6	10·7	(33·3)	5	(23)
72 ...	—	—	(46·7)	(8·6)	7	—	(3·5)	—

Entries in brackets are extrapolations or estimates.

COMPARISON OF BRITISH NUCLEAR HEIGHT OF BURST CURVES WITH AMERICAN
(British data avoid thermal steaming of ground, thus apply to modern cities)



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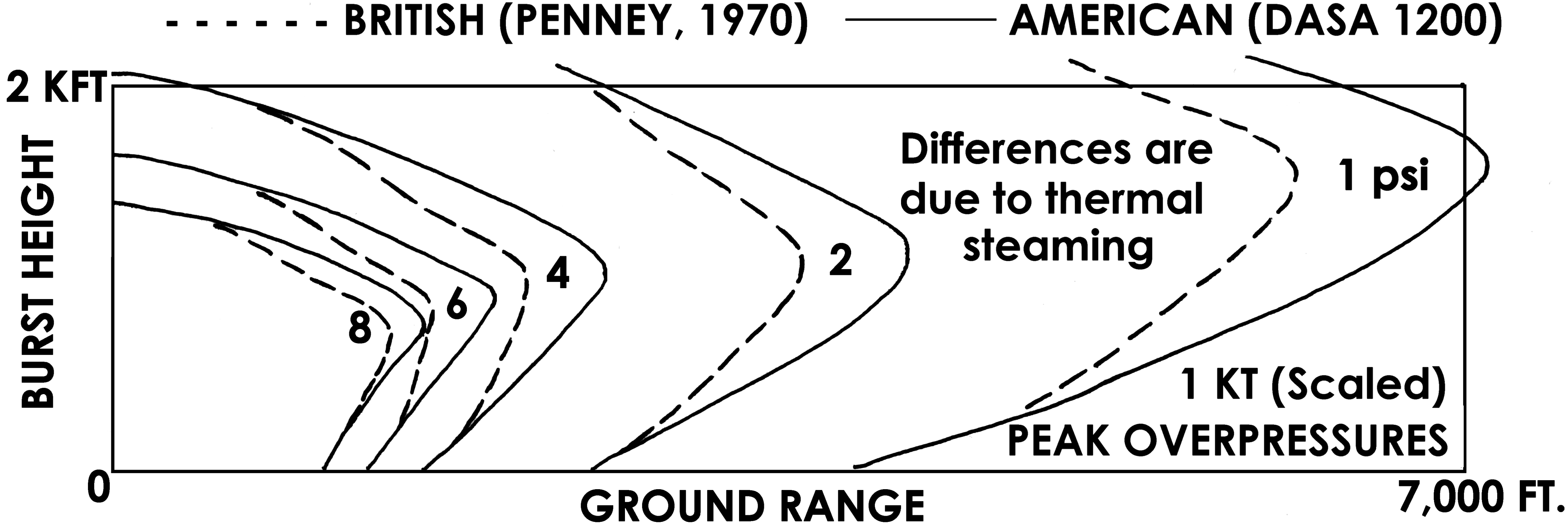
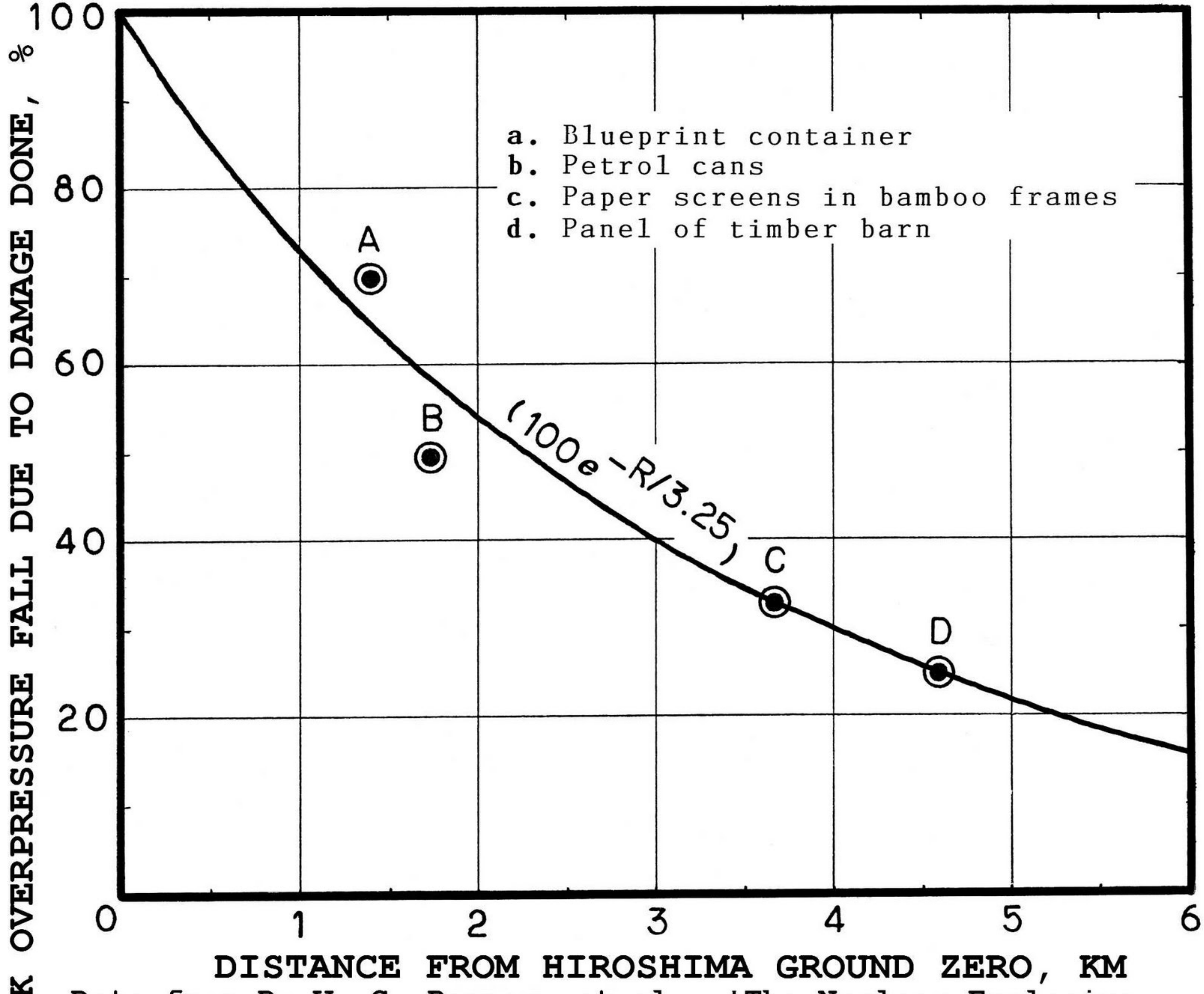
(British data avoid thermal steaming of ground, thus apply to modern cities)



Lord Penney (1970) explains that the thermal energy deposited on desert surface before the blast arrives adds energy to the near-surface blast (hot air steams upward rapidly by convection; this is for 1-15 kt low yield air bursts that do NOT popcorn the desert sand, so there is NO precursor dust storm, just heated air). Where ground range >> burst height, in a modern city the first high rise building absorbs the majority of the thermal flash energy, preventing this effect. (Penney proves that modern buildings in Hiroshima and Nagasaki actually ABSORBED blast energy, causing a further attenuation factor, not included above.)



Data from Dr W. G. Penney, et al., 'The Nuclear Explosive Yields at Hiroshima and Nagasaki', Phil. Trans. Roy. Soc., v266 (1970), pp. 357-424.

HOME OFFICE
SCOTTISH HOME DEPARTMENT

MANUAL OF CIVIL DEFENCE

Volume I

PAMPHLET No. 2

RADIOACTIVE FALL-OUT

PROVISIONAL SCHEME OF PUBLIC CONTROL

LONDON
HER MAJESTY'S STATIONERY OFFICE
1956

Radioactive Fall-out—Summary of Provisional Control Zones

Zone	Definition of Zone Boundaries	Range of Cumulative Doses in open at 48 hours	Summary of permissible and recommended action	Range of Cumulative Doses assuming observance of control rules
W	Outer: Limit of area placed under "Black Warning" (*see* Footnote). Inner: 0·3 r.p.h. at 48 hrs.	Up to 80r	Complete release from refuge as soon as dose-rate fell to 0·3 r.p.h. or, if the rate had not reached that figure, when fall-out was complete.	At 48 hrs. Below 2r
X	Outer: 0·3 r.p.h. at 48 hrs. Inner: 3 r.p.h. at 48 hrs.	80–800r	Qualified release from refuge after 48 hrs.—indoor workers to follow normal occupations, but not to exceed 4 hrs. per day in the open. Outdoor workers to work half shifts for next five days. At the end of this period the zone would be normal, except that all would be advised to be out of doors as little as possible and not in any case to exceed 8 hrs. per day in the open for the next three months.	At 48 hrs. 2-20r At 7 days 6-60r At 5 wks. 12-120r At 3 mths. 14-145r
Y	Outer: 3 r.p.h. at 48 hrs. Inner: 10 r.p.h. at 48 hrs.	800-2,800r	Release from refuge under stringent control after 48 hrs. For the next 12 days people should not leave their refuge for longer than necessary. Time in the open should not exceed 2 hrs. per day and time under cover, but not in refuge, a further 8 hrs. On this basis essential indoor workers should be able to get to their places of work, but outdoor work would remain suspended; a relaxation would be possible after the first fortnight and further easement in another three weeks. For the rest of the first year, however, people in this zone should not exceed 8 hrs. a day in the open.	At 48 hrs. 20-70r At 14 days 50-170r At 5 wks. 70-240r At 3 mths. 95-330r
Z	10 r.p.h. at 48 hrs.	Above 2,800r	All movement outside refuge accommodation in this zone would be dangerous. People should remain in refuge until instructions for clearance were given—they should then leave the zone by the quickest available route if they had means of transport or wait in their refuge to be collected if they had not. The clearance operation might start after 48 hrs. and removal from the zone would be for at least 3 months.	At 48 hrs.—Above 70r

The initial Zone W boundary would be defined by the boundaries of a series of warning districts on the flanks of the fall-out. After 48 hrs. Zone W would for public control purposes have disappeared: its outer boundary would have moved during the period to coincide with the outer boundary of Zone X.

The question of defining an area extending in some places beyond Zone W in which there might be an agricultural hazard is being studied.

TECHNICAL ANALYSIS REPORT - AFSWP NO. 507

RADIOACTIVE FALL-OUT HAZARDS FROM SURFACE BURSTS OF VERY HIGH YIELD NUCLEAR WEAPONS

by

D. C. Borg
L. D. Gates
T. A. Gibson, Jr.
R. W. Paine, Jr.

MAY 1954

HEADQUARTERS, ARMED FORCES SPECIAL WEAPONS PROJECT
WASHINGTON 13, D. C.

e. Passive defense measures, intelligently applied, can drastically reduce the lethally hazardous areas. A course of action involving the seeking of optimum shelter, followed by evacuation of the contaminated area after a week or ten days, appears to offer the best chance of survival. At the distant downwind areas, as much as 5 to 10 hours after detonation time may be available to take shelter before fall-out commences.

f. Universal use of a simply constructed deep underground shelter, a subway tunnel, or the sub-basement of a large building could eliminate the lethal hazard due to external radiation from fall-out completely, if followed by evacuation from the area when ambient radiation intensities have decayed to levels which will permit this to be done safely.

Table II

Total Isodose Contour: 500r from Fall-out to H+50 Hours

Yield (MT)	15	1	10	60
Downwind extent (mi)	180	52	152	340
Area (mi^2)	5400	470	3880	17,900

HOME OFFICE
SCOTTISH HOME DEPARTMENT

General Information

(All Sections)

CIVIL DEFENCE
POCKET BOOK NO. 3

LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

Zone	Dose-rate at H+48 hours	Summary of permissible and recommended action
W	Less than 0.3 r.p.h.	Remain in refuge until released, which can be as soon as dose-rate falls to 0.3 r.p.h. or when fall-out is complete if the rate has not reached that figure.
X	0.3—3 r.p.h.	Remain in refuge until H+48 hours; then qualified release. Indoor workers to follow normal occupations, but not to exceed 4 hours per day in the open for the next 5 days. Outdoor workers would have to do half shifts to keep within this figure. At the end of a week the zone would be normal, except that all would be advised to be out of doors as little as possible, and not in any case to exceed 8 hours per day in the open for the next 3 months.
Y	3—10 r.p.h.	Remain in refuge until at least H+48 hours; then release under stringent control. For the next 12 days time in the oper should not exceed 2 hours per day. On this basis essential indoor workers should be able to get to their work, but outdoor work would remain suspended. After the first fortnight it would be possible to increase the essential time spent out of doors to 4 hours per day for the next three weeks, increasing this to 8 hours per day thereafter for the rest of the first year.
Z	10 r.p.h. or more	Remain in refuge until told to leave. All movement outside refuge in this zone would be dangerous. People should remain until instructions for clearance are given; they should then leave by the nominated route if they have means of transport—or wait in their refuge to be collected if they have not. The clearance operation might start after H+48 hours and removal from the Zone would be for at least 3 months.

HOME OFFICE

SCOTTISH HOME DEPARTMENT

MANUAL OF CIVIL DEFENCE

Volume I

PAMPHLET No. 1

NUCLEAR WEAPONS

LONDON

HER MAJESTY'S STATIONERY OFFICE

1956

Practical protection

88 Large buildings with a number of storeys, especially if they are of heavy construction, provide much better protection than small single-storey structures (see Figure 4). Houses in terraces likewise provide much better protection than isolated houses because of the shielding effect of neighbouring houses.

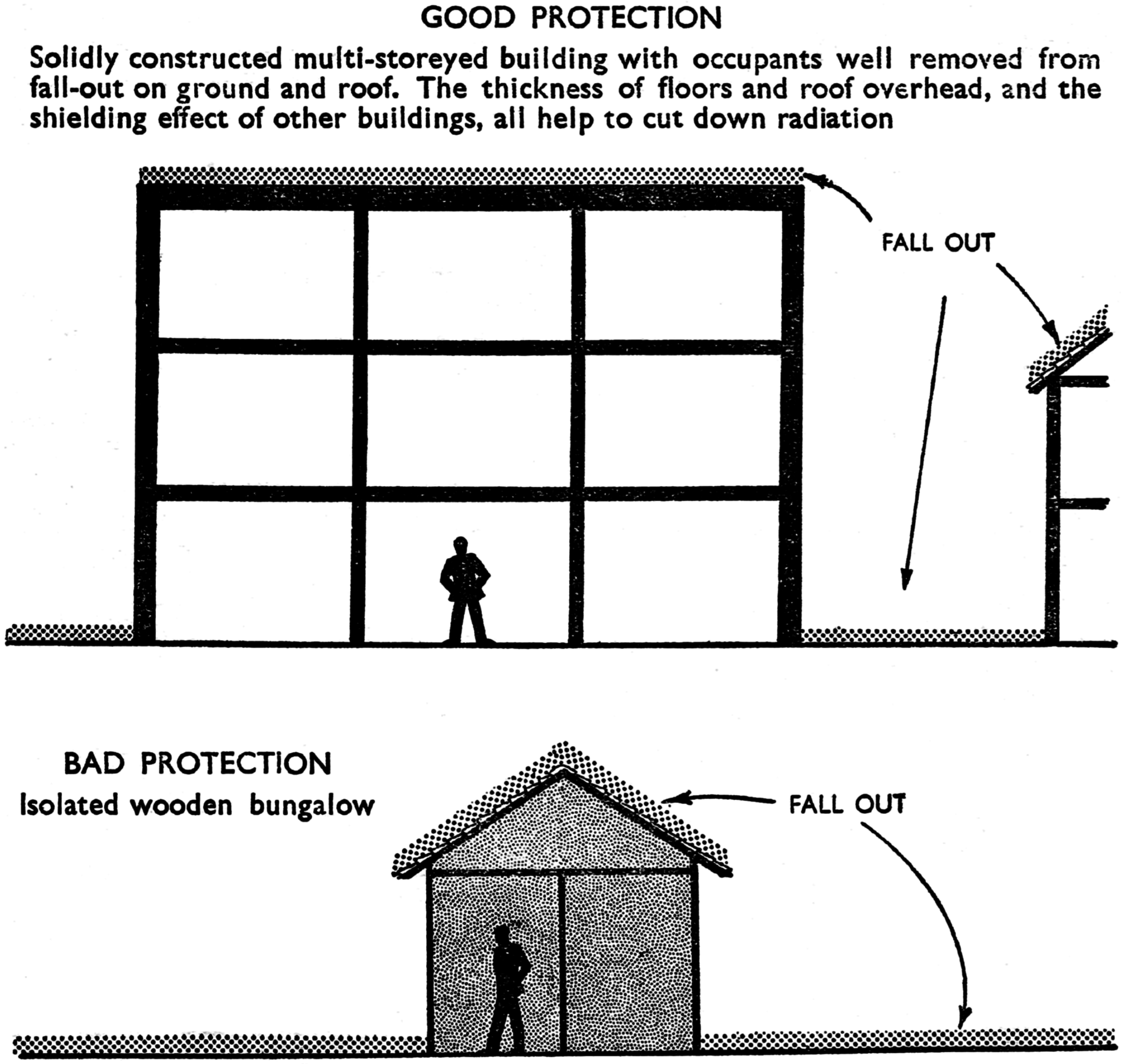


FIGURE 4

Examples of good and bad protection afforded by buildings against fall-out.

89 It is estimated that the protection factor (the factor by which the outside dose has to be divided to get the inside dose) of a ground floor room in a two-storey house ranges from 10 to about 50, depending on wall thickness and the shielding afforded by neighbouring buildings. The corresponding figures for bungalows are about 10–20, and for three-storey houses about 15–100. An average two-storey brick house in a built-up area gives a factor of 40, but basements, where the radiation from outside the house is attenuated by a very great thickness of earth, have protection factors ranging up to 200–300. A slit trench with even a light cover of boards or corrugated iron without earth overhead gives a factor of 7, and if 1 ft. of earth cover is added the

factor rises to 100. If the trench can be covered with 2 or 3 feet of earth then a factor of more than 200–300 can be obtained (see Figure 5).

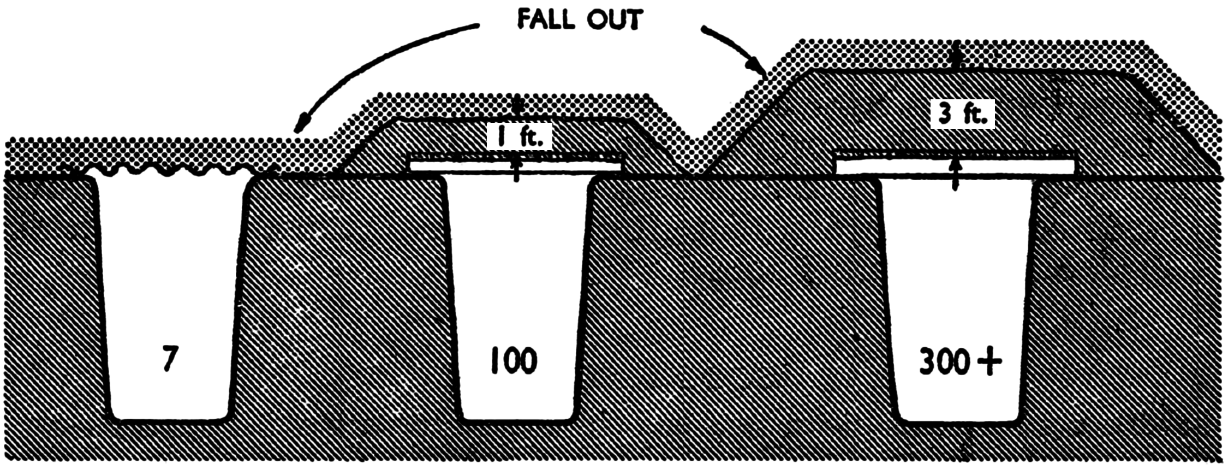


FIGURE 5

Protection factors in slit trenches (the factor by which the outside dose is divided to get the inside dose).

Choosing a refuge room

90 In choosing a refuge room in a house one would select a room with a minimum of outside walls and make every effort to improve the protection of such outside walls as there were. In particular the windows would have to be blocked up, e.g. with sandbags. Where possible, boxes of earth could be placed round an outside wall to provide additional protection, and heavy furniture (pianos, bookcases etc.) along the inside of the wall would also help. A cellar would be ideal. Where the ground floor of the house consists of boards and timber joists carried on sleeper walls it may be possible to combine the high protection of the slit trench with some of the comforts of the refuge room by constructing a trench under the floor.

Once a trap door had been cut in the floor boards and joists and the trench had been dug, there would be no further interference with the peace-time use of the room.

Estimated under-cover doses in the fall-out area

91 Taking an average protective factor of 40 for a two-storey house in a built-up area, the doses accumulated in 36 hours for the ranges referred to in the U.S. Atomic Energy Commission Report (paragraph 84) would have been:—

190 miles downwind	7½r	15 Megatons
160 ,, ,,	12½r	Bravo 1954
140 ,, ,,	20r	

which are all well below the lowest figure of 25r referred to in Table 1. At closer ranges along the axis of the fall-out, the doses accumulated in 36 hours would have been much higher, but over most of the contaminated area—with this standard of protection—the majority of those affected would have been saved from death, and even from sickness, by taking cover continuously for the first 36 hours.

5. **Radiation sickness**

Assume dose incurred in a single shift (3–4 hours) by the "average" man, over the whole body:—

25 roentgens	—No obvious harm.
100 „	—Some nausea and vomiting.
500 „	—Lethal to about 50 per cent. people (death up to 6 weeks later).
800 „ or more	—Lethal to all (death up to 6 weeks later).

Note: If dose spread uniformly over 2–3 days, then 60 roentgens could be incurred with no more effect than 25 roentgens in a single exposure of 3–4 hours.

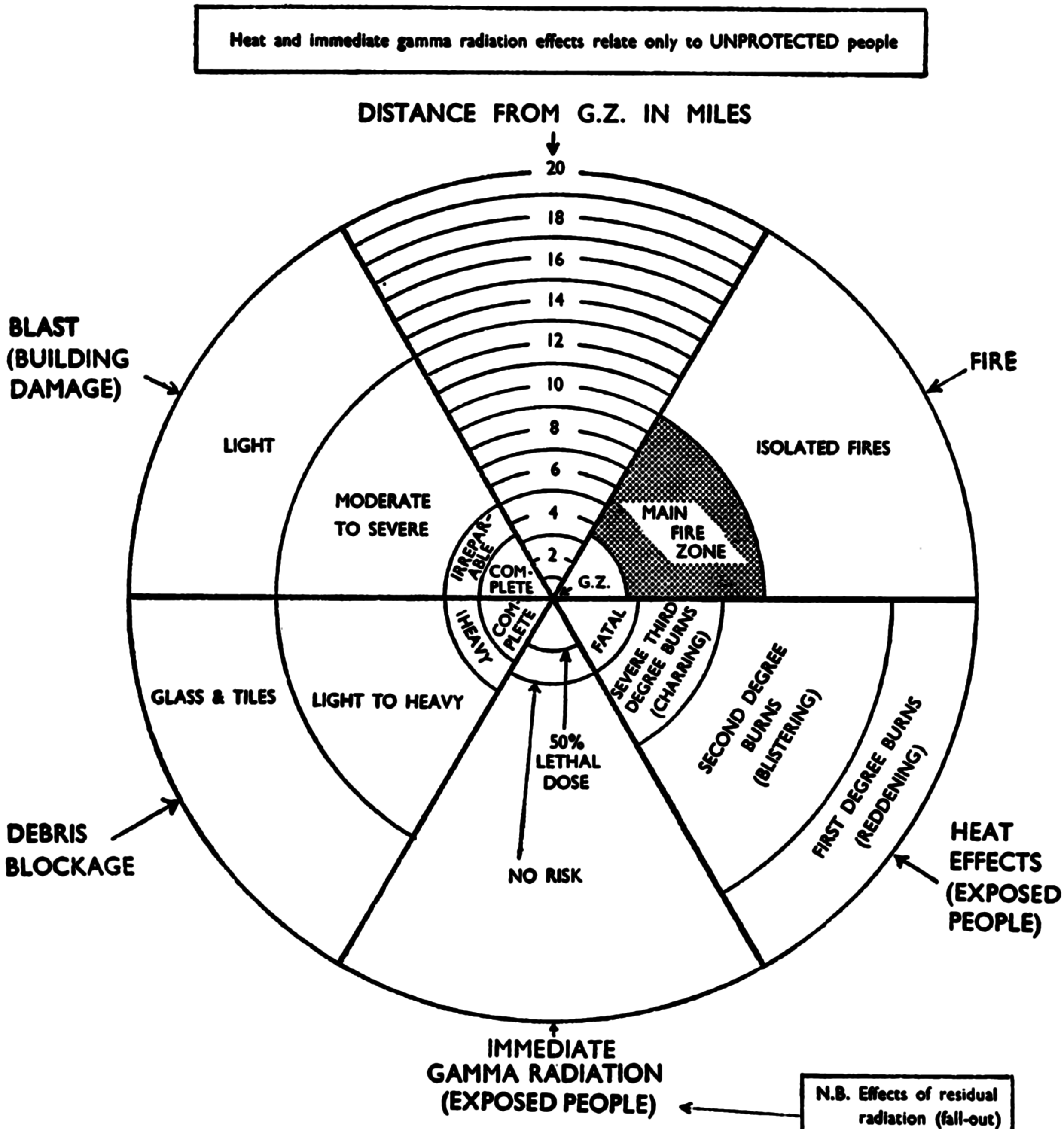


FIGURE 11

Combined effects (excluding residual radioactivity) from a 10 megaton ground burst bomb. Heat and immediate gamma radiation effects relate only to UNPROTECTED people.

HOME OFFICE

CIVIL DEFENCE

TRAINING MEMORANDUM No. 3

The Control of Civil Defence Operations under Fall-out Conditions (England and Wales)

LONDON

HER MAJESTY'S STATIONERY OFFICE

1959

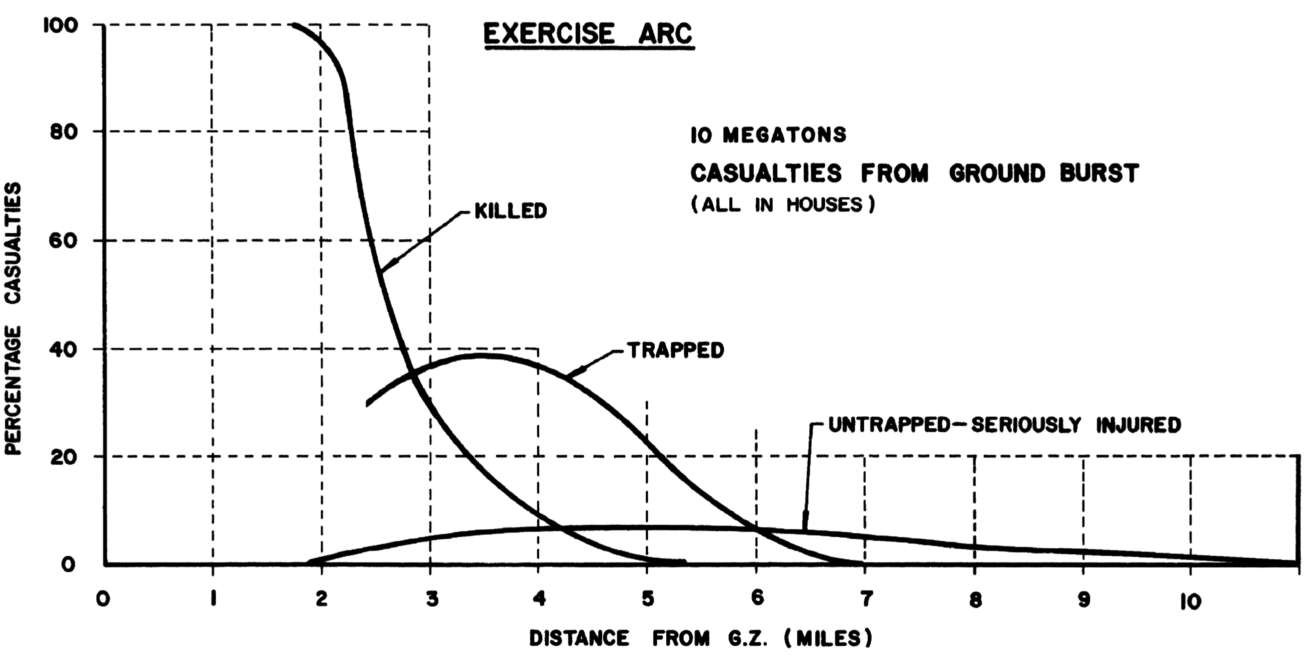
SIXPENCE NET

Civil Defence Training Memorandum No. 3, "The Control of Civil Defence Operations under Fall-out Conditions," U.K. Home Office, 1959

Paragraphs 6-14 explain that the need for rapid life-saving rescue and evacuation from the damaged areas near ground is to be balanced by the fallout gamma dose rate hazard to the civil defence workers; for optimum results first aid and rescue workers should move inwards (toward ground zero) at about the same speed the 10 R/hour gamma outdoor dose rate contour moves inward due to the natural radioactive decay of fallout (because fallout radiation decays rapidly, the dose rate at 48 hours being only about 1% of that at 1 hour):

"The balance of advantage would differ according to the nature of the work; but for the rescue and casualty services it is thought that the best results would be obtained from working at or about a dose rate of 10 R/hour, so that the wartime emergency dose [75 R] was used up in a single shift of about 8 hours. … Some forces, e.g. ambulances, could operate profitably where their dose was spread out over longer periods than 8 hours by working at lower dose rates than 10 R/hour. Others, e.g. reconnaissance parties with special responsibility for rapid penetration, might have to take their wartime emergency dose without heed to the 10 R/hour [fallout map pattern/contour] line and reduce their working period accordingly. … units would continue with their task … with reference only to the total dose accumulated on their dosimeters. … The radiological limit should be taken as the 1,000 R/hour at H + 1 contour which will be 10 R/hour line at H + 48 [due to the 100 fold decay of fallout radiation between 1 and 48 hours after a nuclear explosion] and so mark the limit to which life-saving forces can be expected to have penetrated by that time. …

"The task will be set by the number of casualties trapped, or seriously injured but untrapped … capable of being succoured within the first 48 hours. As soon as possible after ground zero, weight and nature of attack are known, the Controller should have casualty estimates made … This will be done by applying the population figures for the Sectors casualty percentages as shown on the graph (from Exercise ARC) attached as an appendix to this memorandum, which sets out, on the best evidence at present available [blast casualties from applying Blitz casualty data as a function of house damage to nuclear test data showing the amount of house damage versus distance from a nuclear explosion, which automatically takes account of the duration of the blast wave in nuclear explosions], the proportions of seriously injured, trapped and untrapped, to be expected at different distances from ground zeroes of bombs of varying power. … A single Forward Medical Aid Unit can be expected to deal with about 120 seriously injured an hour – say 1,000 in each shift – and to continue working throughout the operational period with only internal reliefs. … At the beginning of operations a 4-berthed ambulance can be expected to take about 1 hour on the round trip from ambulance loading point … A single casualty collecting party can handle and send to ambulance loading points about 12 seriously injured an hour, or, say, 100 per shift [8 hours]. … A single [light] rescue party [using slow manual methods used in 1941, without any of the tracked cranes and rescue dogs used to rapidly clear debris off casualties in 1944-1945, during the V1 and V2 attacks on London] can release two or three trapped persons an hour or, say, 20 per shift."



USNRDL-TR-1049
28 July 1966

REMOVAL OF SIMULATED FALLOUT FROM ASPHALT STREETS BY FIREHOSING TECHNIQUES

by

L.L. Wiltshire

W.L. Owen

In general, removal effectiveness improves with increased particle size range and increased mass loading. For the expenditure of an effort of 4 nozzle-minutes (12 man-minutes) per 10^3 ft^2, results ranged as follows:

Particle Size Range (μ)	Nominal Mass Loading (g/ft^2)	Removal Effectiveness (Residual Fraction)
44 - 88	4.0	0.16
	24.0	0.07
350 - 700	4.0	0.005
	24.0	0.003

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY

SAN FRANCISCO · CALIFORNIA 94135

FALLOUT DECONTAMINATION, RETENTION AND UPTAKE

'A number of factors make large-scale decontamination useful in urban areas. Much of the area between buildings is paved and, thus, readily cleaned using motorized flushers and sweepers, which are usually available. If, in addition, the roofs are decontaminated by high-pressure hosing, it may be possible to make entire buildings habitable fairly soon, even if the fallout has been very heavy.' – Dr Frederick P. Cowan and Charles B. Meinhold, *Decontamination,* Chapter 10, pp. 225-40 of Dr Eugene P. Wigner (editor), *Survival and the Bomb,* Indiana University Press, Bloomington, 1969.

Measured Efficiency of Decontamination by Firehosing Dry Fallout Deposits*

1-hour dose rate:	300 R/hr	1,000 R/hr	3,000 R/hr
Fallout deposit:	100 g/m^2	330 g/m^2	1,000 g/m^2
Portland cement concrete	96%	98%	99.2%
Tar and gravel roof	97%	98%	99%
Galvanised steel	95%	98%	99.4%
Smooth painted surface	96%	99%	99.6%

**Radiological Recovery of Fixed Military Installations,* U.S. Army Chemical Corps technical manual TM-3-225, 1958. Firehosing uses 4 cm diameter hoses, each crewed by 2-4 people, and utilising 100 gallons/minute of water; each hose decontaminates 700 m^2/hour. The water pressure needed is 5 atmospheres. The fallout is flushed into underground drain sewers with the water.

According to fallout decontamination studies on paved areas at distances of 600-1600 m from the 1951 *Sugar* nuclear surface burst and *Uncle* shallow underground burst: 'High-pressure water hosing was found to be the most rapid and effective procedure tested... None of the tested procedures [which included dry sweeping and vacuum cleaning] resulted in significant contamination of the operator's protective clothing.' (J.C. Maloney, *Decontamination of Paved Areas,* weapon test report WT-400, chapter 5, 1952.)

Priority firehosing of residential areas would be needed where the 1-hour dose rate is between 500-3,000 R/hr. At lower dose rates, there will be few casualties in any case (200 R being assumed to produce a 'casualty'), while at higher dose rates the hazard to decontamination crews is considered excessive, so protection would there depend on radiation shielding or evacuation. Decontamination could begin when the outdoor dose rate had decayed to 10 R/hr, i.e., 1-5 days after detonation for 1-hour dose rates of 500-3,000 R/hr. People in these zones must remain under cover indoors until decontamination is done. (An American study by Stanford Research Institute, *Systems Analysis of Radiological Defense,* in 1958 assumed that 1% of the population would be available to staff decontamination crews, and that each crew member is allowed a dose of 100 R.)

A study of decontamination was done by J.A. Miles of the British Home Office Scientific Adviser's Branch in 1965, *The Value of Area Decontamination in Reducing Casualties from Radioactive Fallout,* SA/PR-97, Secret. Miles found that firehosing roads, pavements, and houses to reduce dose rates by a factor of 4 requires 57,000 litres of water and 37 human-hours of effort per kilometre length of terraced streets; but twice this water and effort is needed for streets of semi-detached houses with front gardens. About 620 people live in each kilometre length of terraced streets, but only about 310 people live in each kilometre length of semi-detached housing. Terraced streets are thus the decontamination priority.

Several tested techniques are available to decontaminate different surfaces. Roads, paved areas, building surfaces, vehicles, aircraft and ships can be decontaminated by water hosing. Farmland requires a different technique. In fallout tests, single-pass deep-ploughing to a depth of 20-25 cm reduced the above-ground gamma radiation level from the fallout by 85%; using a 125 horse-power tractor with a 3-share plough, 3,250 m^2/hour was deep-ploughed. (*Radiological Recovery of Fixed Military Installations,* U.S. Army Chemical Corps technical manual TM-3-225, 1958.) Fallout is deep-ploughed to a depth below the root length of the crops, or alternatively the long-term agricultural uptake of strontium-90 and cesium-137 is simply diluted by adding chemically-similar calcium and potassium salts (respectively) to contaminated soil.

On smooth ground, it is possible to literally sweep away surrounding dry fallout with a broom, or to swill it down drains using an ordinary low pressure hose pipe. For concrete, 1 m height, and 0.7 MeV fallout gamma rays, the protection is:

Circular radius of decontaminated area (m)	Protection factor for the actual removal of fallout	Protection factor for just sweeping fallout to edge
5	1.4	1.3
10	1.8	1.5
15	2.0	1.8
30	2.7	2.3
60	4.1	3.5

There are three basic stages during radiological recovery from a nuclear war: (1) evacuation of old people with inadequate radiation shielding from heavy fallout areas if they are unable to improve their shielding sufficiently with sandbags, (2) sheltering in heavy fallout areas for a few days in the part of the house furthest from the roof and outside walls, with as much mass shielding of the inner refuge as possible while the intense danger falls sharply by natural radioactive decay, and (3) outdoor decontamination to avoid long-term exposure.

It is also possible to essentially avert the entire fallout problem by using the washdown system during fallout deposition. It is more effective to fix up a cheap water hose spray to clean the roof, walls, and surrounding urban paved areas while fallout is landing, than to spend money on sheltering, which will not remove a single fallout particle! Focus on expensive sheltering and measuring of radiation was a mistake made by Herman Kahn of the RAND Corporation in 1958, and has unfortunately overshadowed the more valuable discovery that if you do not waste time, you can just wash the fallout down the drain! (Kahn thought just in terms of an invisible radiation problem, not in terms of a physical fallout problem.) The continuous washdown system was tested on manned ships during the 1950s nuclear tests, having been developed after a study of the 1946 Bikini fallout problems. If you leave the fallout for weeks, decontamination becomes more difficult, because particles end up firmly lodged in crevices, and you also miss the benefit of reducing the intense early time hazard.

F.T. Underwood of the British Home Office Scientific Adviser's Branch, reported fallout adherence studies between 1961-5 (reports CD/SA-103 and CD/SA-125). Underwood glued sheets of 0.13 cm thick PVC plastic on to London house roofs. They were fully intact for 1 year and lost only 10% area coverage after another year during winter storms. PVC covered roofs retain few fallout particles, and are smooth enough that light rain or a small water spray will decontaminate them. For a 45-degree roof slope, 90% of the retained fallout on PVC is removed by just 1 litre/m^2 of water (i.e., 0.1 cm of rainfall).

Without PVC, much more water is needed to first fill up all the pits and crevices in the roof where fallout particles are lodged, before they can be carried away. Over 90% of fallout particles that exceeded 1 mm in diameter rolled or bounced quickly enough to overcome friction, and fell straight of roofs with a 45-degree slope. However, 95% of fallout particles smaller than 0.2 mm in diameter adhered to a 45-degree sloping ceramic tiled roof, because they slowly rolled into small pits and crevices where they lodged. R.T. Graveson reported in 1956 that the normal roof of a fallout-contaminated typical American house in the Nevada desert was decontaminated by 5 cm of natural rainfall, causing in a reduction of the gamma dose rate within the house by a factor of 15 (*Radiation Protection within a Standard Housing Structure,* Nevada Test Site report NYO-4714). Studies of skin decontamination by E. Neale and E. H. Letts's paper *Radiological Decontamination: Removal of Dry Fallout from Skin and Clothing,* British Chemical Defence Experimental Establishment, Porton Technical Paper PTP-R-16, 1958, showed that washing removed 100% of dry fallout particles of 100 microns or more in diameter, but only 97.5% of particles with a diameter of 20 microns. Denim overalls are decontaminated with 90% efficiency in 5 minutes by a washing machine (100 revolutions per minute with 1% detergent), for particle diameters exceeding 10 microns.

Research on Removing Radioactive Fallout From Farmland

By P. E. JAMES, *agricultural engineer, Physical Control Laboratory, Northeastern Region,* and R. G. MENZEL, *soil scientist, Water Quality Laboratory, Southern Region, Agricultural Research Service*

US Department of Agriculture, Agicultural Research Service, Technical Bulletin 1464 (1973)

TABLE 12.—*Experiment K: Percentage of radioactivity determined at various depths after deep plowing*

Sampling depth (inches)	Radioactivity of high-clay content Pullman soil	Radioactivity of sandy loam Elkton soil
	Percent	*Percent*
3	0.5	0.5
9	.3	.5
15	1.2	.7
21	1.7	4.2
27	6.2	29.2
33	27.4	62.6
39	61.4	2.0

A power-driven streetsweeper or scraper cutting 2 inches deep removes about 90 percent of the contaminant.

Decontamination should be accomplished before rainfall washes the radioactivity into low places where it is difficult to remove.

Decontamination can be accomplished by a scraper with a 12-foot blade at the rate of 100,000 square feet (2.3 acres) in 3.3 hours.

Application of a concrete or asphalt coating over the radioactivity is ineffective and only makes later pickup of radioactivity more difficult.

Burying radioactivity 3 feet deep with a large plow is costly and ineffective in reducing the uptake of radioactivity.

Planting through a contaminated surface which is then left untilled is an ineffective way to reduce the uptake of radioactivity.

The species of the crop is a highly significant factor in the uptake of radioactivity.

TABLE 13.—*Experiment L: Uptake of strontium-85 by mature crops grown with different tillage operations and a growth inhibitor*

Crop	Fraction of strontium-85 application taken up with different treatments		
	Rotary-tilled	Deep-plowed	Deep-plowed with Na_2CO_3
	Percent $\times 10^4$	*Percent* $\times 10^4$	*Percent* $\times 10^4$
Sugarbeet tops	640	300	39
Sugarbeet roots	910	780	76
Sudangrass fodder	780	450	52
Soybean straw	650	540	35
Soybean seed	67	56	6
Cabbage	1,130	560	154

each sample was recorded. Table 13 summarizes the uptake of strontium-85 by mature crops grown with different tillage operations and a growth inhibitor.

To investigate the effectiveness of a conventional-type streetsweeper in removing fallout from contaminated land, Experiment M was conducted during the fall (table 14). The following variables: Type of soil, sweeping procedures, type of broom material, and use of gutter broom were considered. Several practical factors make mechanical streetsweepers attractive. Sweepers leave the topsoil relatively undisturbed; they are maneuverable in corners and around objects, and are much less destructive than scrapers to hard surfaces such as roads.

The soil type and condition were important factors in decontaminating. It was easier to decontaminate sandy soil than silty loam during the initial passes. Four passes were required on silty loam soil to achieve 90-percent decontamination, whereas, only three were required on a sandy soil. The fields were decontaminated after a rain and, consequently, were wet. Other results might occur from sweeping dry fields.

Investigations of the sweeping procedures showed that after three passes, a point of diminishing return for the effort expended occurs. Nevertheless, 10 passes removed 99 percent of the contamination. The sweeper operated as effectively at high groundspeed as it did when going slower. Higher speeds are preferable since the operator receives less exposure.

A steel wire main broom was more effective than a plastic main

TABLE 14.—*Experiment M: Cumulative percentage of radioactivity reduced by repeated passes of a rotating-brush, mechanical street sweeper with different brooms* [1]

Broom material and sweeping procedure	Cumulative percent removed from Sassafrass sandy soil by indicated number of passes					Cumulative percent removed from Elkton silt-loam soil by indicated number of passes				
	1	2	3	4	10	1	2	3	4	10[2]
Main brooms	*Duplicative*					*Duplicative*				
Steel:										
Normal pass first	74	86	91	92	------	80	89	75	92	------
Suction pass first	73	86	92	94	100	84	95	85	94	------
Steel and gutter broom:										
Normal pass first	73	84	92	96	99	78	90	95	94	------
Suction pass first	52	75	93	90	------	50	54	77	78	------
Plastic:										
Normal pass first						38	51	70	90	------

[1] Data for results with the motorized vacuum sweeper and the rotary brush sweeper were recorded, but were not put in tabular form.

[2] The final part of this experiment was not conducted.

Health and Biology
(TID-4500, 11th Ed.)

THE ABSORPTION BY PLANTS OF BETA-EMITTING FISSION PRODUCTS FROM THE BRAVO SOIL

By

A. A. Selders, J. F. Cline and J. H. Rediske

Plant Nutrition and Microbiology Unit
Biology Section
Radiological Sciences Department

December 20, 1955

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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ABSTRACT

Barley and bean plants were grown to maturity (87 days) in soil from a Pacific island which contained fallout material from the Bravo shot. The leaves of bean and barley plants showed a concentration factor of 0.05 and 0.02, respectively, for the total beta emitters absorbed.

Leaves of both bean and barley plants had a higher concentration of fission products than did the fruit. Addition of nutrients to the soil decreased the uptake of fission products into the bean plant but had no effect on uptake into barley.

With the exception of those for cesium, concentration factors for the individual elements were comparable with values previously obtained in the laboratory using local soils. The concentration factor of 4-8 for cesium is over 20 times higher than is obtained using local soils. All values are determined on oven dried material.

TABLE 3

CONCENTRATIONS OF EMITTERS FOUND IN BRAVO SOIL AND 87-DAY-OLD PLANTS GROWN IN THIS SOIL, EITHER WITH OR WITHOUT ADDED NUTRIENT

Element	Soil	With Nutrient				Without Nutrient			
		Bean		Barley		Bean		Barley	
		Leaves	Pods	Leaves	Heads	Leaves	Pods	Leaves	Heads
	mμc/g	CF*	CF	CF	CF	CF	CF	CF	CF
Rare Earths and yttrium	30	0.007	0.002	0.007	0.001	0.03	0.003	0.002	0.002
$Sr^{89 \text{ and } 90}$	0.2	7	1	3.5	0.5	15	2	5	0.4
Zr^{95}	4	0.008	0.005	0.01	0.003	0.03	0.008	0.02	0.01
Cs^{137}	0.1	1	2	Not determined	3	5	6	8	5
$Ru^{103-106}$	0.8	0.04	0.01	0.04	0.04	0.51	0.03	0.05	0.03

*Concentration factor expressed as $\frac{\mu c/g \text{ in plant part}}{\mu c/g \text{ in soil}}$ on dry weight basis.

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

THE UPTAKE OF IODINE BY HIGHER PLANTS

A. A. Selders and J. H. Rediske
Plant Nutrition and Microbiology Unit
Biology Section

September 30, 1954

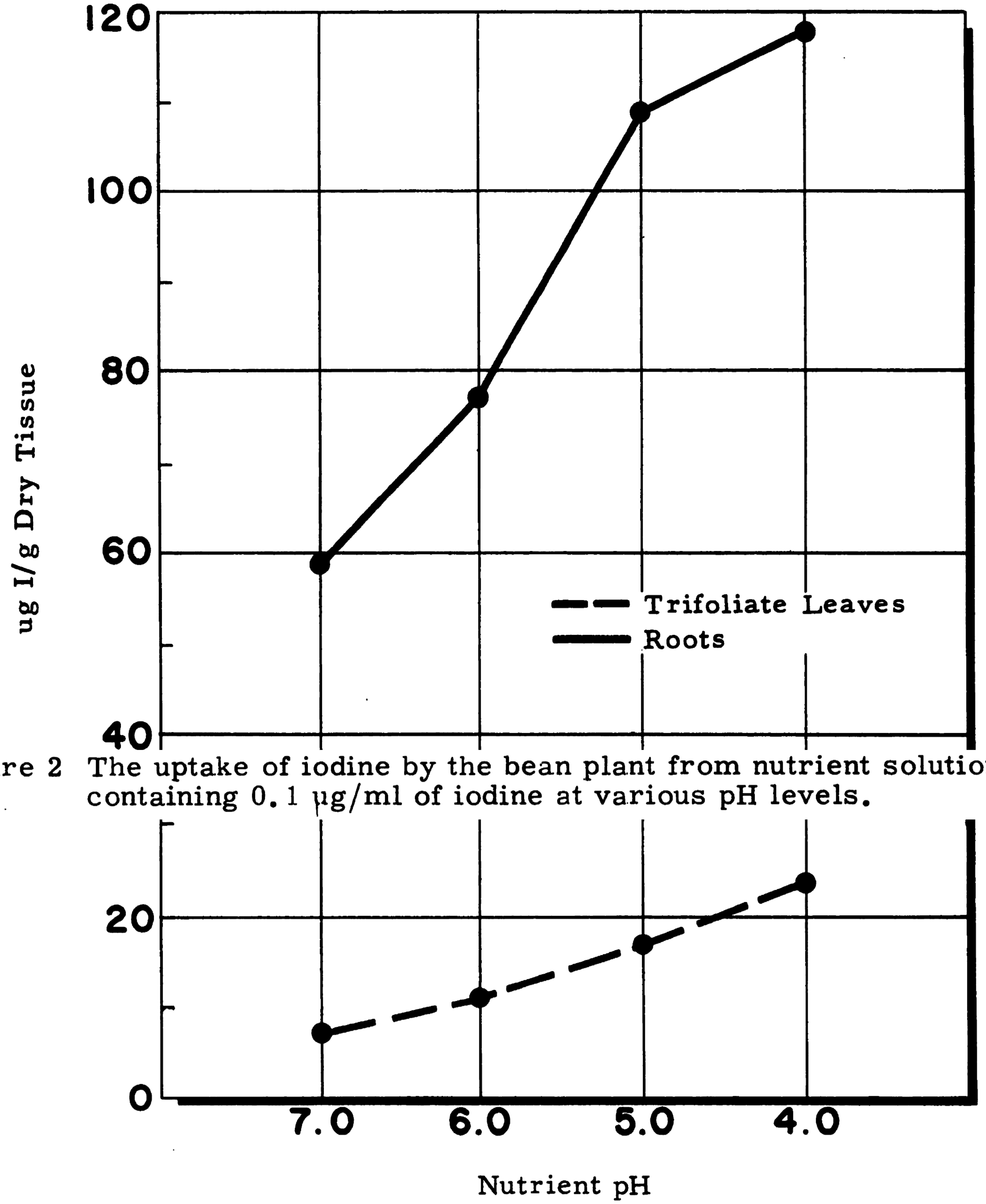

Figure 2 The uptake of iodine by the bean plant from nutrient solutions containing 0.1 μg/ml of iodine at various pH levels.

Survival of Food Crops and Livestock in the Event of Nuclear War

Proceedings of a symposium held at
Brookhaven National Laboratory
Upton, Long Island, New York
September 15–18, 1970

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Editors

David W. Bensen
Office of Civil Defense
Arnold H. Sparrow
Brookhaven National Laboratory

December 1971

U. S. ATOMIC ENERGY COMMISSION Office of Information Services

THE SIGNIFICANCE OF LONG-LIVED NUCLIDES AFTER A NUCLEAR WAR

R. SCOTT RUSSELL, B. O. BARTLETT, and R. S. BRUCE
Agricultural Research Council, Letcombe Laboratory, Wantage, Berkshire, England

ABSTRACT

The radiation doses from the long-lived nuclides ^{90}Sr and ^{137}Cs, to which the surviving population might be exposed after a nuclear war, are considered using a new evaluation of the transfer of ^{90}Sr into food chains.

As an example, it is estimated that, in an area where the initial deposit of near-in fallout delivered 100 R/hr at 1 hr and there was subsequent worldwide fallout from 5000 Mt of fission, the dose commitment would be about 2 rads to the bone marrow of the population and 1 rad to the whole body. Worldwide fallout would be responsible for the major part of these doses.

It is now widely recognized that long-lived fission products would make a negligible contribution to the radiation exposure of the population in heavily contaminated areas shortly after a nuclear attack. The external radiation dose would usually be dominant, and, if simple precautions were taken to avoid the superficial contamination of foodstuffs, the entry of ^{131}I into milk would cause the only important problem of dietary contamination. Thus, for example, infants probably would not receive doses of more than 0.1 rad to bone marrow from ^{90}Sr nor more than 0.01 rad from ^{137}Cs in the weeks after a nuclear attack if they were fed continuously with milk produced in an area where the external dose rate at 1 hr after detonation had been 100 R/hr. Doses to the thyroid from ^{131}I might, however, exceed 200 rads.

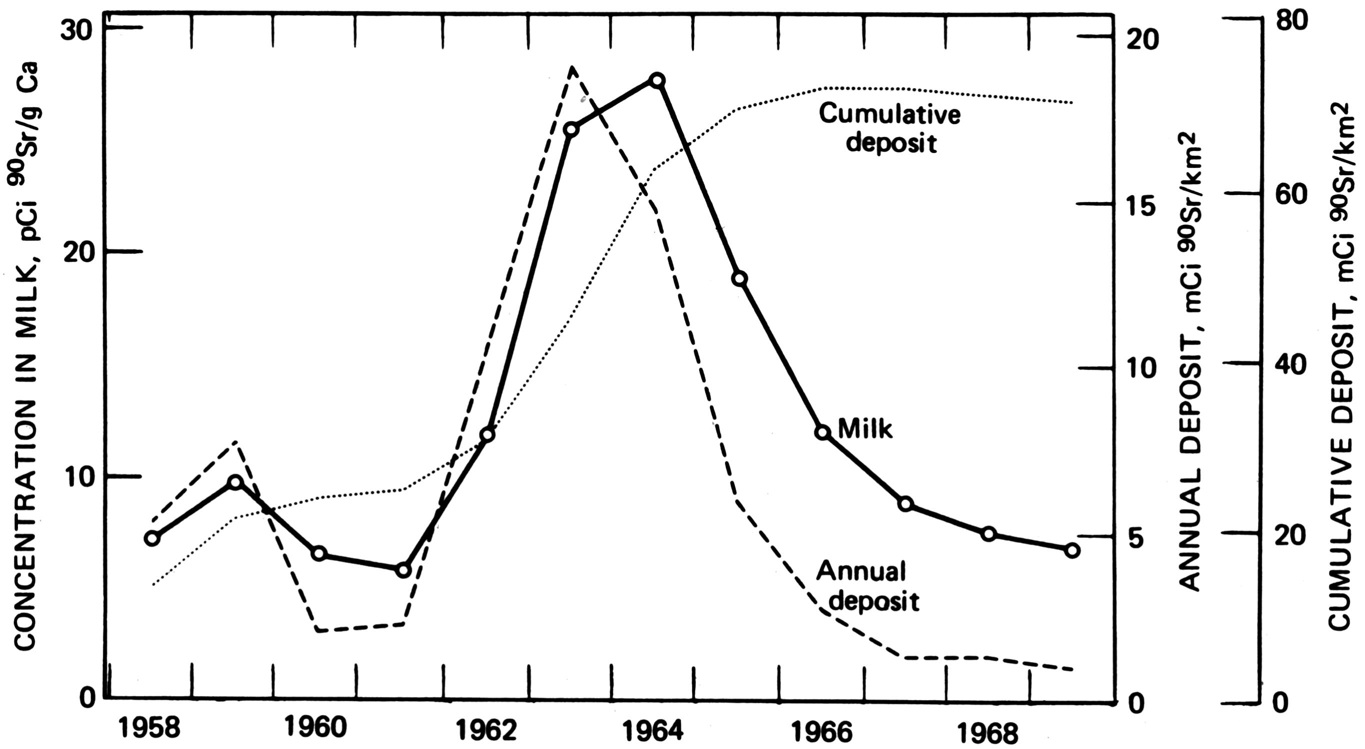


Fig. 1 Strontium-90 in fallout and milk in the United Kingdom, 1958 to 1969.

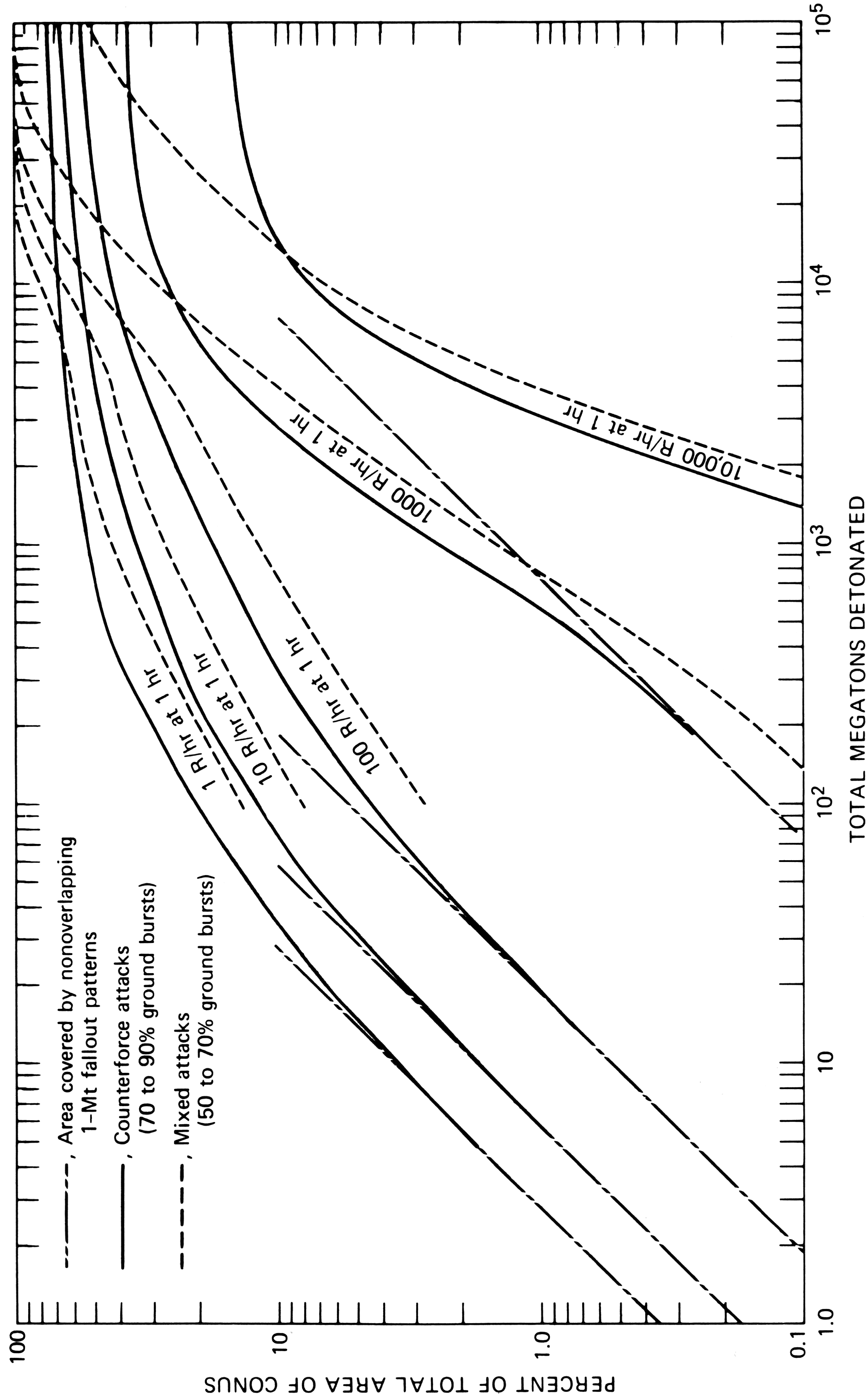
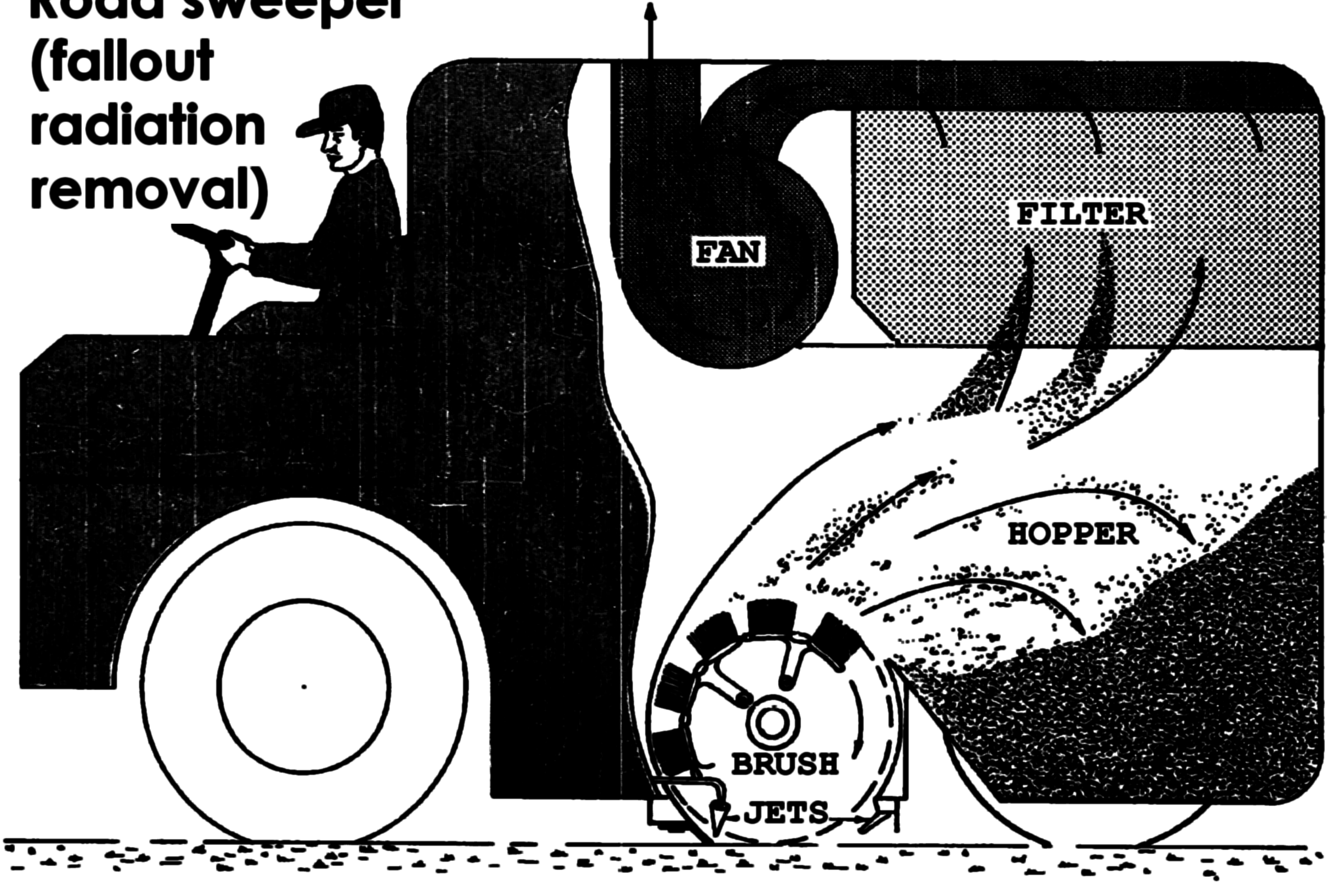


Fig. 1 Percent of area of the continental United States enclosed within selected I_S contours as a function of attack weight (50% fission weapons).

Road sweeper (fallout radiation removal)




TRINITY GROUND ZERO:
8000 R/hr at 1 hour
1.4 R/hr at
57 days
11 Sept. 1945

CLEAN BOMB: 3.53 MT (15% FISSION) ZUNI

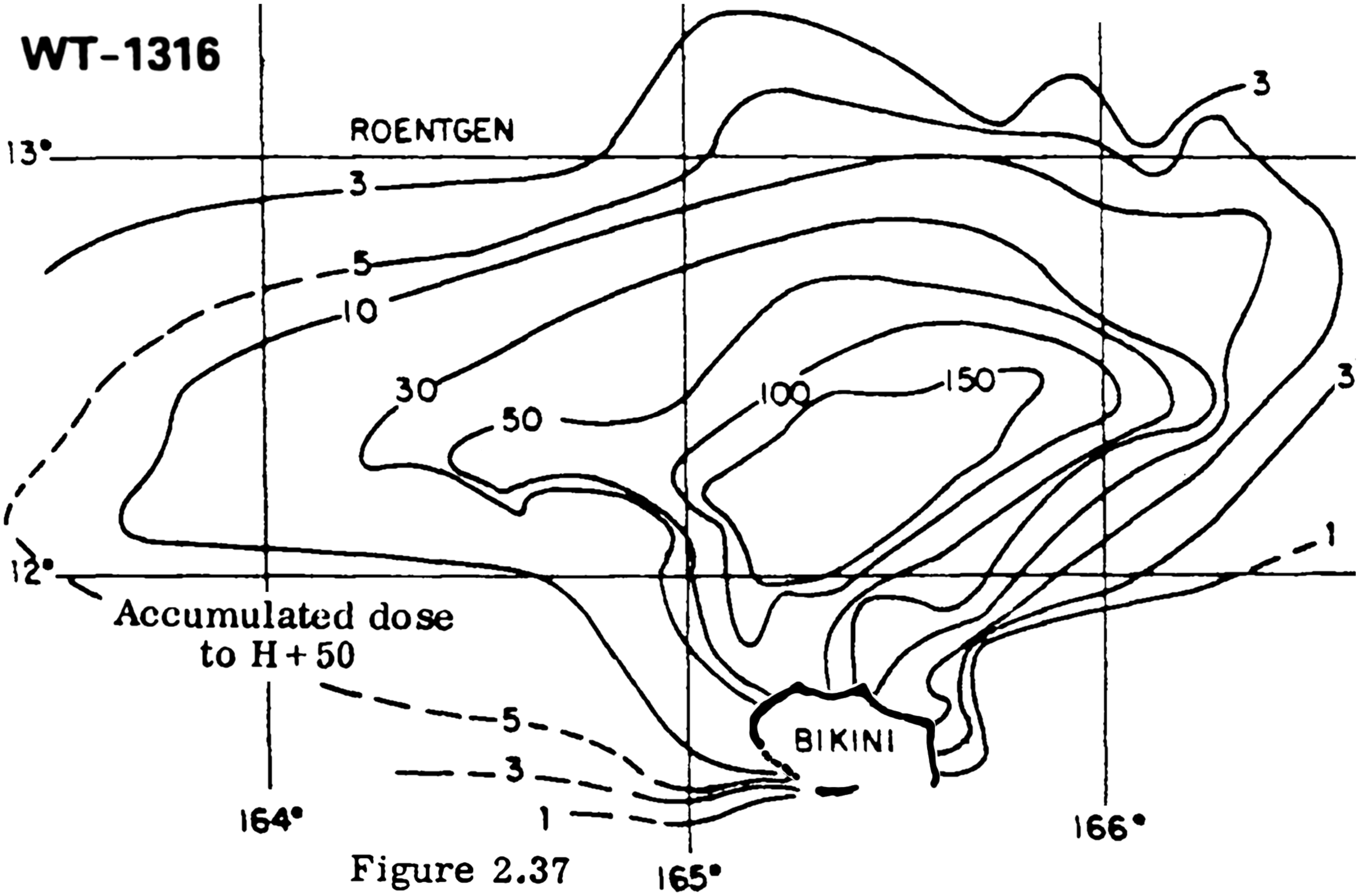


Figure 2.37

DIRTY BOMB: 5.01 MT (87% FISSION) TEWA

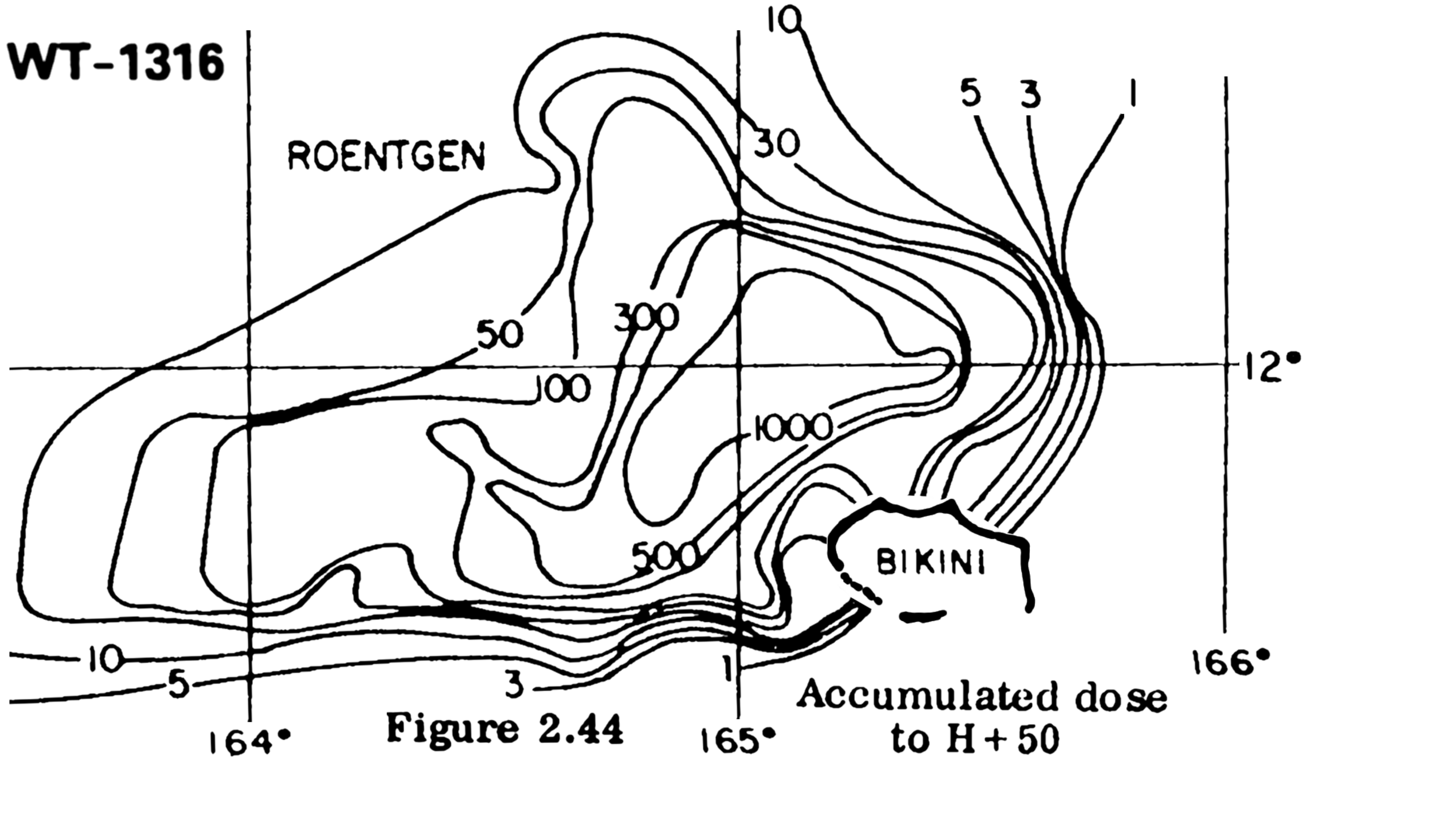


Figure 2.44

TABLE 2.11

	Navajo	Tewa
Total Yield, Mt	4.50	5.01
Fission proportion	5% (CLEAN)	87% (DIRTY)

H + 1 Hour Dose Rate (r/hr)	Area (mi^2) Within Contour	
1,000	25	450
500	55	1,050
300	80	1,550
100	310	3,500

Two-day Dose, R	Area (mi^2) Within Contour	
1,000	20	520
500	30	1,050
300	45	1,500
100	350	3,000

LAND SURFACE BURST

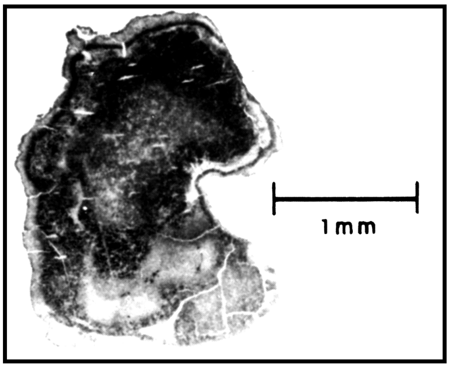
A Fallout Forecasting Technique With Results Obtained at the Eniwetok Proving Ground

E. A. Schuert, USNRDL TR–139, United States Naval Radiological Defense Laboratory, San Francisco, Calif.

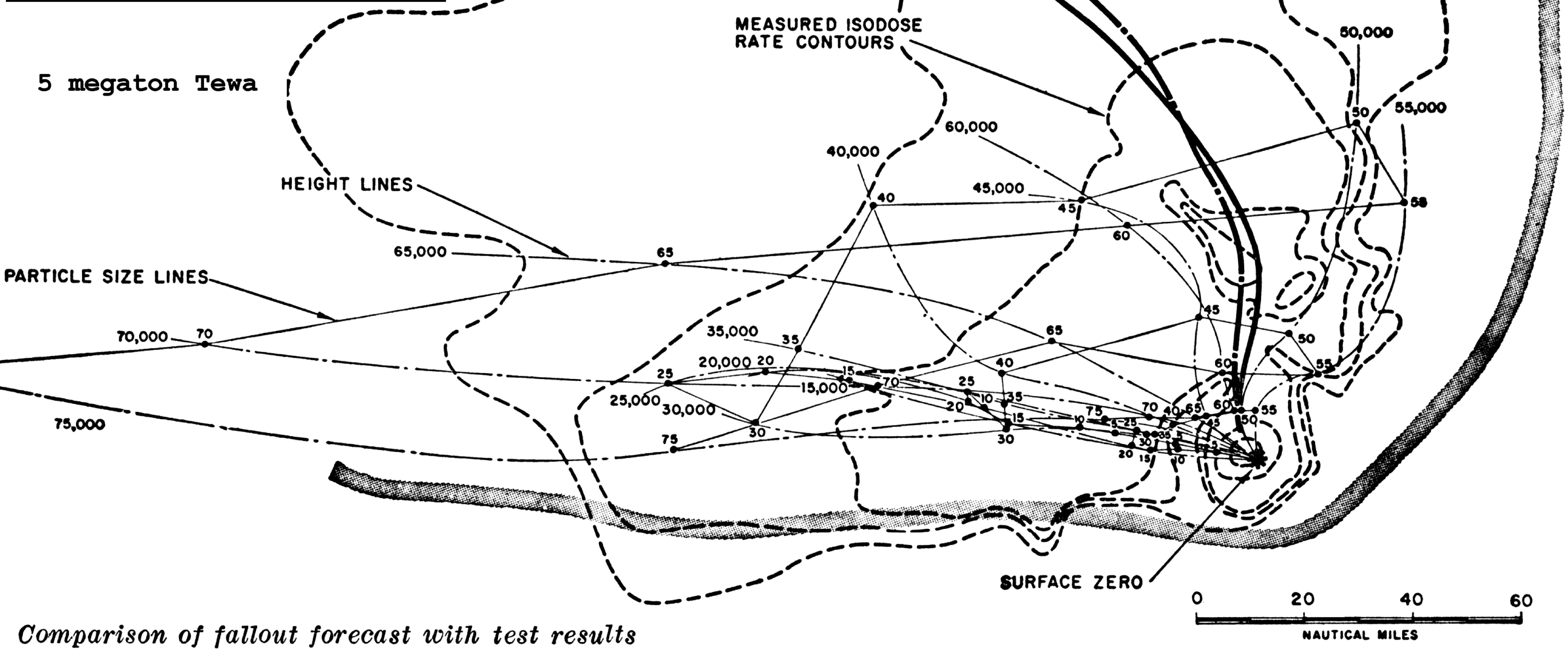
2.36 g/cu cm irregular in shape

Falling speeds (feet/hour)

Altitude	75 μ	100 μ	200 μ	350 μ
0	3,060	5,040	11,700	21,600
20	3,360	5,980	14,400	27,100
40	3,870	6,910	18,600	35,300
60	4,200	7,700	24,400	47,200
80	3,910	6,960	27,800	61,900



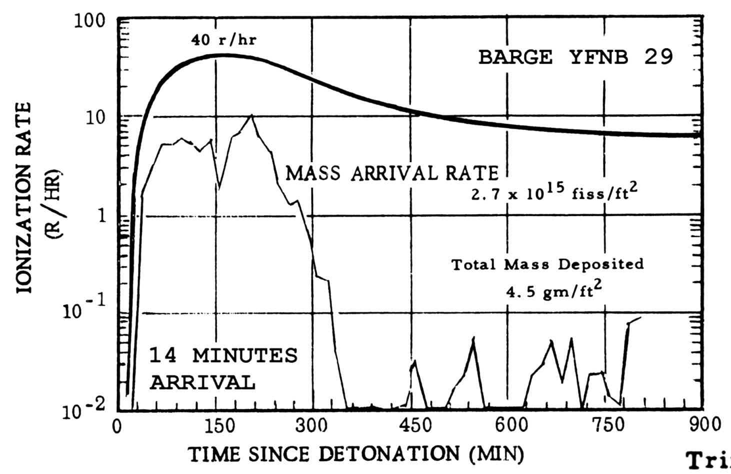
5 megaton Tewa



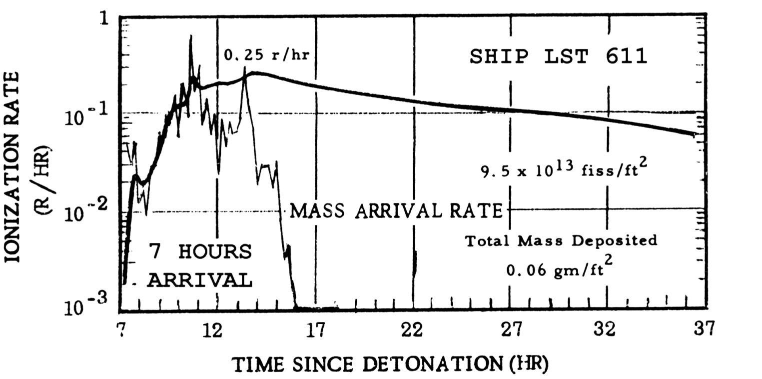
Comparison of fallout forecast with test results

HEIGHT LINE = DESTINATIONS FOR A FIXED HEIGHT OF ORIGIN FOR VARIOUS SIZES
SIZE LINE = DESTINATIONS FOR A FIXED PARTICLE SIZE FROM VARIOUS HEIGHTS
HOT LINE = HEIGHT LINE FROM BASE OF MUSHROOM DISC (MAXIMUM FALLOUT)

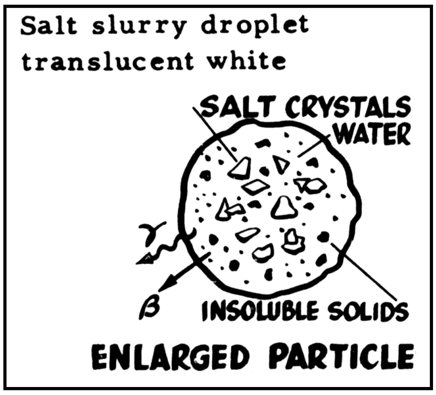
5 MT TEWA (87% FISSION), 7.84 STAT. MILES WSW



5 MT TEWA (87% FISSION), 59.3 STAT. MILES NW



Triffet, T. and LaRiviere, P. D.; Characterization of Fallout



WATER SURFACE BURST

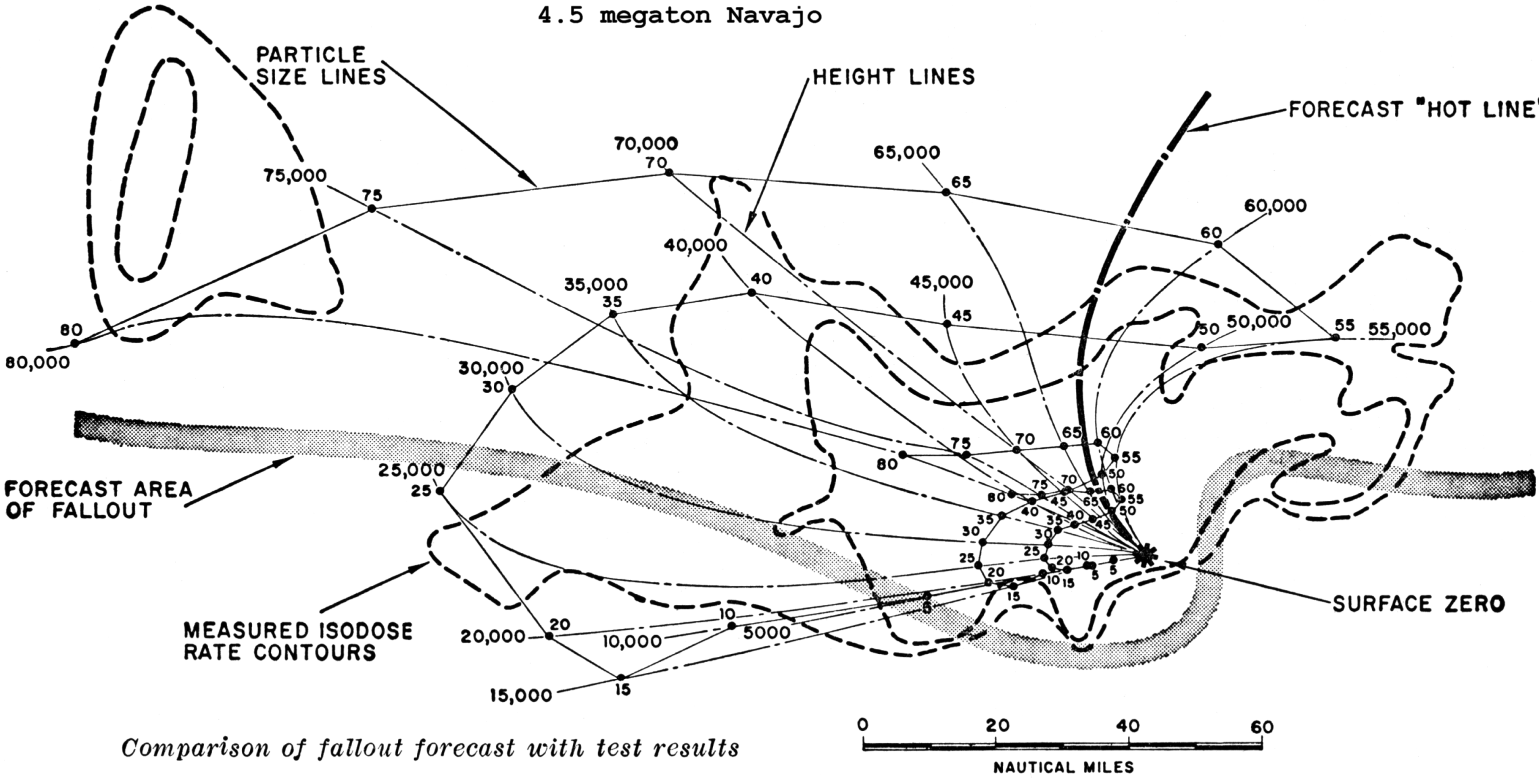
A Fallout Forecasting Technique With Results Obtained at the Eniwetok Proving Ground

E. A. Schuert, USNRDL TR–139, United States Naval Radiological Defense Laboratory, San Francisco, Calif.

Time variation of the winds aloft

In most of the observations made at the Eniwetok Proving Ground, the winds aloft were not in a steady state. Significant changes in the winds aloft were observed in as short a period as 3 hours. This variability was probably due to the fact that proper firing conditions which required winds that would deposit the fallout north of the proving ground, occurred only during an unstable synoptic situation of rather short duration.

4.5 megaton Navajo



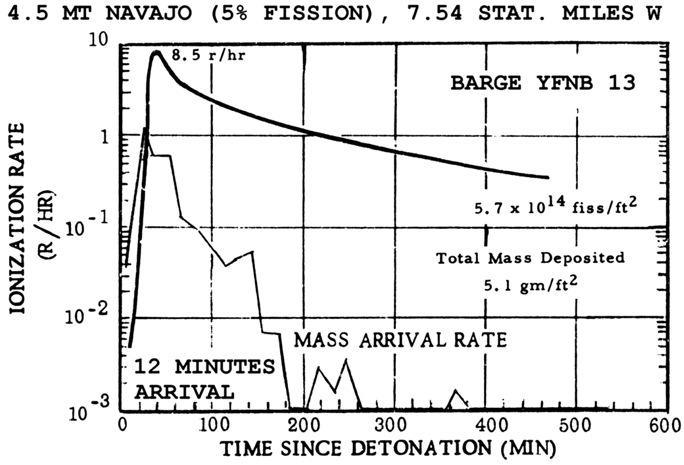
Comparison of fallout forecast with test results

HEIGHT LINE = DESTINATIONS FOR A FIXED HEIGHT OF ORIGIN FOR VARIOUS SIZES

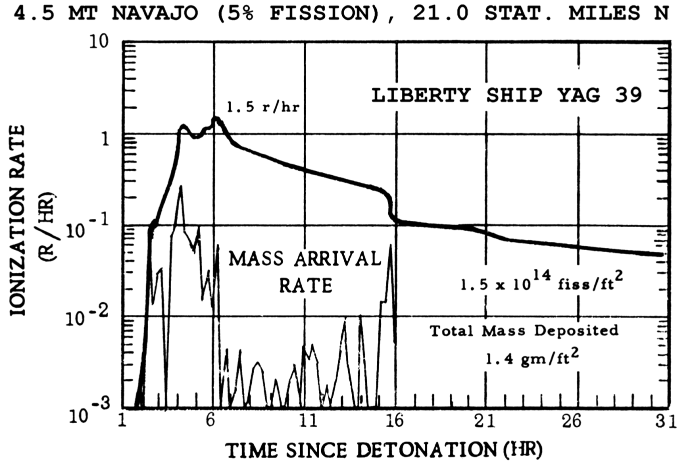
SIZE LINE = DESTINATIONS FOR A FIXED PARTICLE SIZE FROM VARIOUS HEIGHTS

HOT LINE = HEIGHT LINE FROM BASE OF MUSHROOM DISC (MAXIMUM FALLOUT)

4.5 MT NAVAJO (5% FISSION), 7.54 STAT. MILES W



4.5 MT NAVAJO (5% FISSION), 21.0 STAT. MILES N

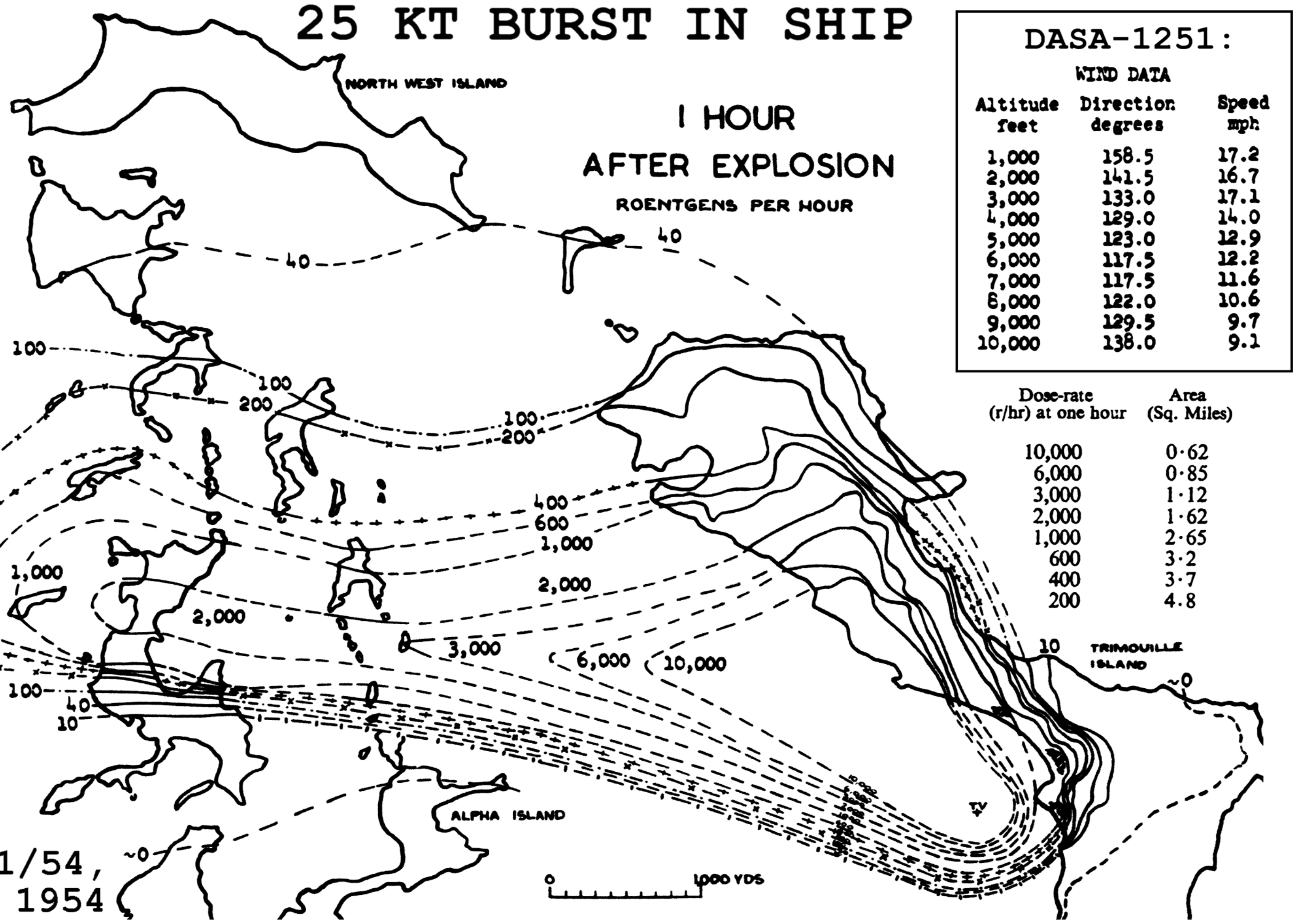


Triffet, T. and LaRiviere, P. D.; Characterization of Fallout, Project 2.63

OPERATION HURRICANE—THE DOSE-RATE CONTOURS OF THE RESIDUAL RADIOACTIVE CONTAMINATION

25 KT BURST IN SHIP

FIG. 7·2



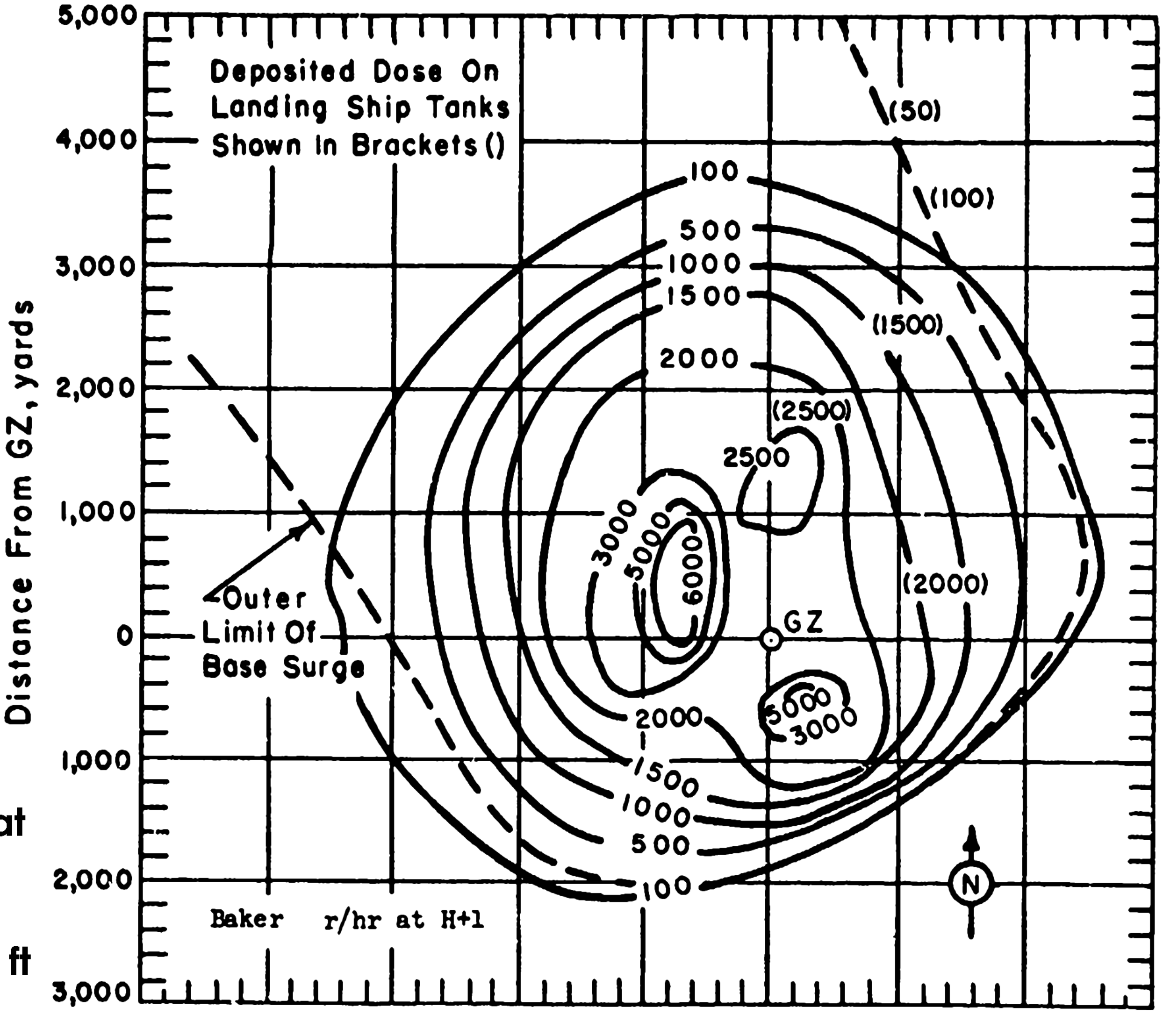
DASA-1251:

WIND DATA

Altitude feet	Direction degrees	Speed mph
1,000	158.5	17.2
2,000	141.5	16.7
3,000	133.0	17.1
4,000	129.0	14.0
5,000	123.0	12.9
6,000	117.5	12.2
7,000	117.5	11.6
8,000	122.0	10.6
9,000	129.5	9.7
10,000	138.0	9.1

Dose-rate (r/hr) at one hour	Area (Sq. Miles)
10,000	0·62
6,000	0·85
3,000	1·12
2,000	1·62
1,000	2·65
600	3·2
400	3·7
200	4·8

AWRE-T1/54, 27 Aug. 1954



23 kt at 90 ft depth in 180 ft water

AD-A995490

POR-2266 (WT-2266)

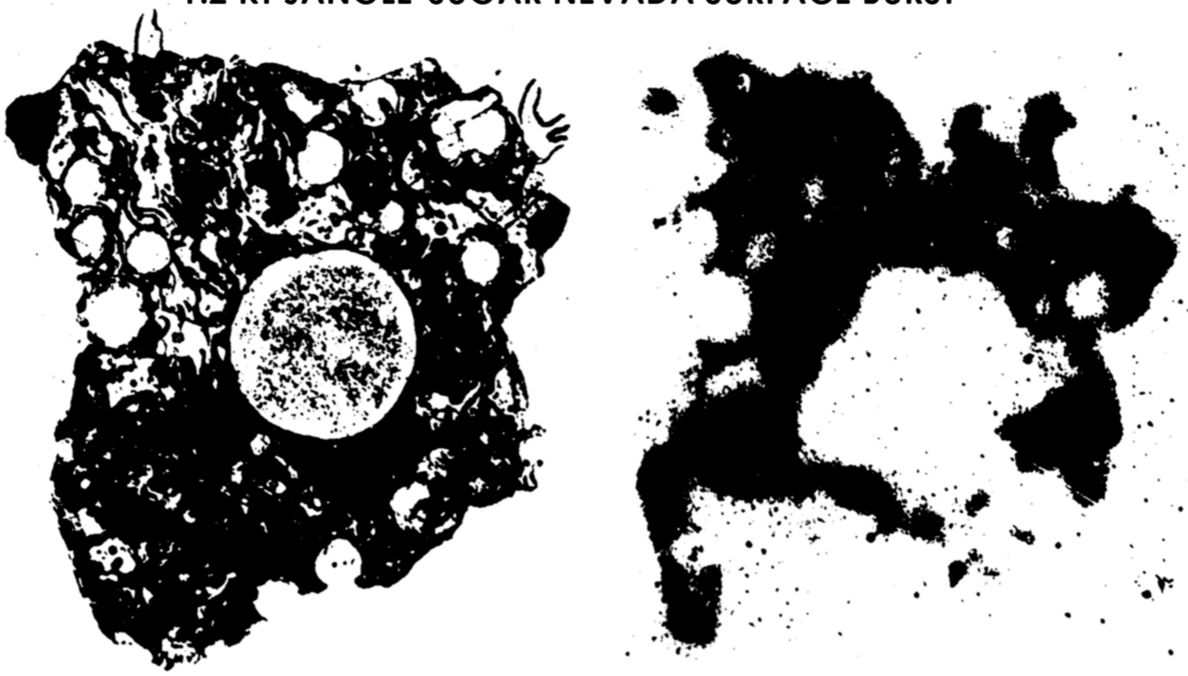
TABLE 4.1

AREAS ENCLOSED BY DOSE RATE CONTOURS

Contour Dose Rate, I	Area Within Contour			
	0.018 kt	0.022 kt	0.5 kt	1.65 kt
	Little Feller I	Little Feller II	Johnie Boy	Small Boy
r/hr	mi^2	mi^2	mi^2	mi^2
0.5	0.33	0.827	-	109.83
1.0	0.208	0.469	33.097	61.63
5.0	-	0.070	-	-
10.0	0.032	0.045	3.924	9.057
20.0	-	0.019	-	-
50.0	-	-	0.536	2.954
100.0	0.00478	0.005	0.214	1.200
200.0	-	-	-	0.285
1,000.0	-	-	0.0917	0.092
2,000.0	-	-	-	0.01665
10,000.0	-	-	0.0161	-
17,000.0	-	-	0.00537	-

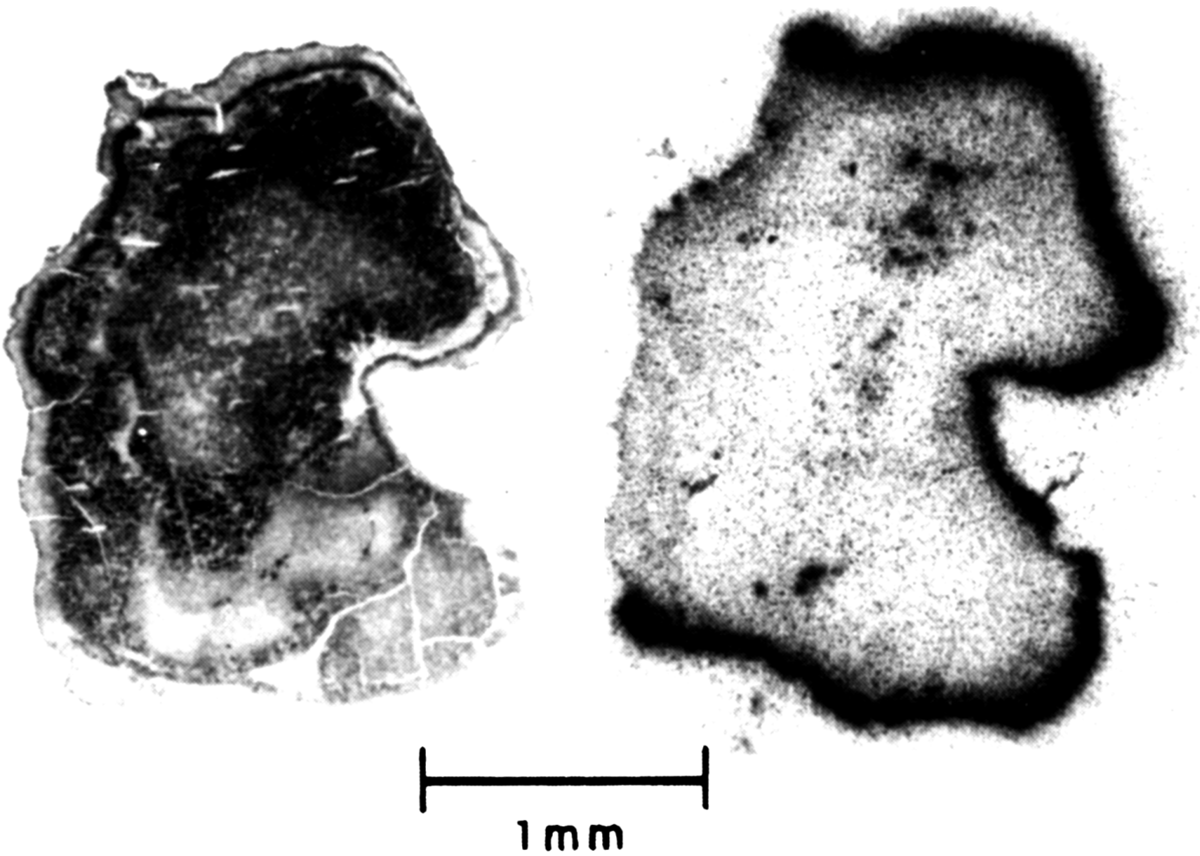
THIN SECTION AND RADIOGRAPH OF A FALLOUT PARTICLE FROM A SMALL-YIELD SURFACE SHOT AT THE NEVADA TEST SITE. THE PARTICLE IS A TRANSPARENT YELLOW-BROWN GLASS WITH MANY INCLUSIONS OF GAS BUBBLES AND UNMELTED MINERAL GRAINS. THE RADIOACTIVITY IS DISTRIBUTED IRREGULARLY THROUGHOUT THE GLASS PHASE OF THE PARTICLE

1.2 KT JANGLE-SUGAR NEVADA SURFACE BURST

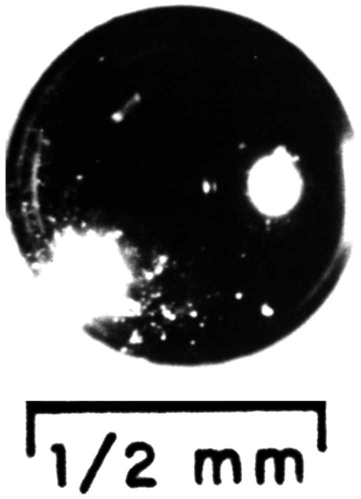


C.E. Adams, et al. The Nature of Individual Radioactive Particles. I. Surface and Underground A.B.D. Particles From Operation JANGLE. U.S. Naval Radiological Defense Laboratory Report, USNRDL-374, November 28, 1952

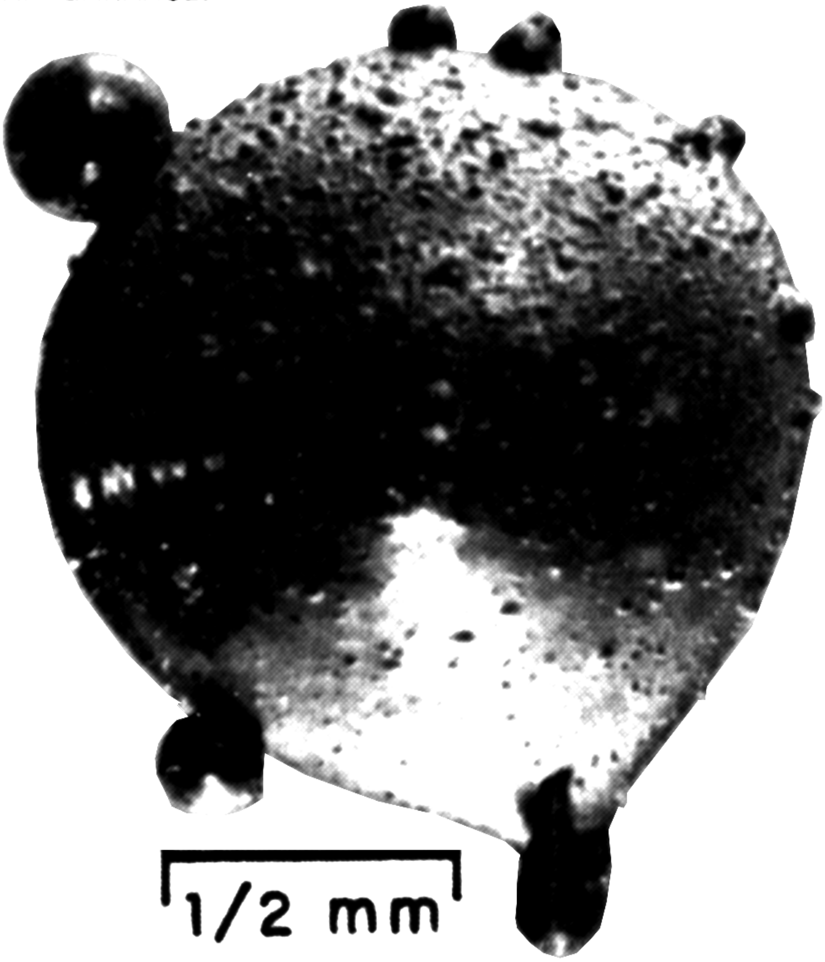
THIN SECTION AND RADIOGRAPH OF AN ANGULAR FALLOUT PARTICLE FROM A LARGE-YIELD SURFACE SHOT AT THE ENIWETOK PROVING GROUNDS. THIS PARTICLE IS COMPOSED ALMOST ENTIRELY OF CALCIUM HYDROXIDE WITH A THIN OUTER LAYER OF CALCIUM CARBONATE. THE RADIOACTIVITY HAS COLLECTED ON THE SURFACE AND HAS DIFFUSED A SHORT DISTANCE INTO THE PARTICLE



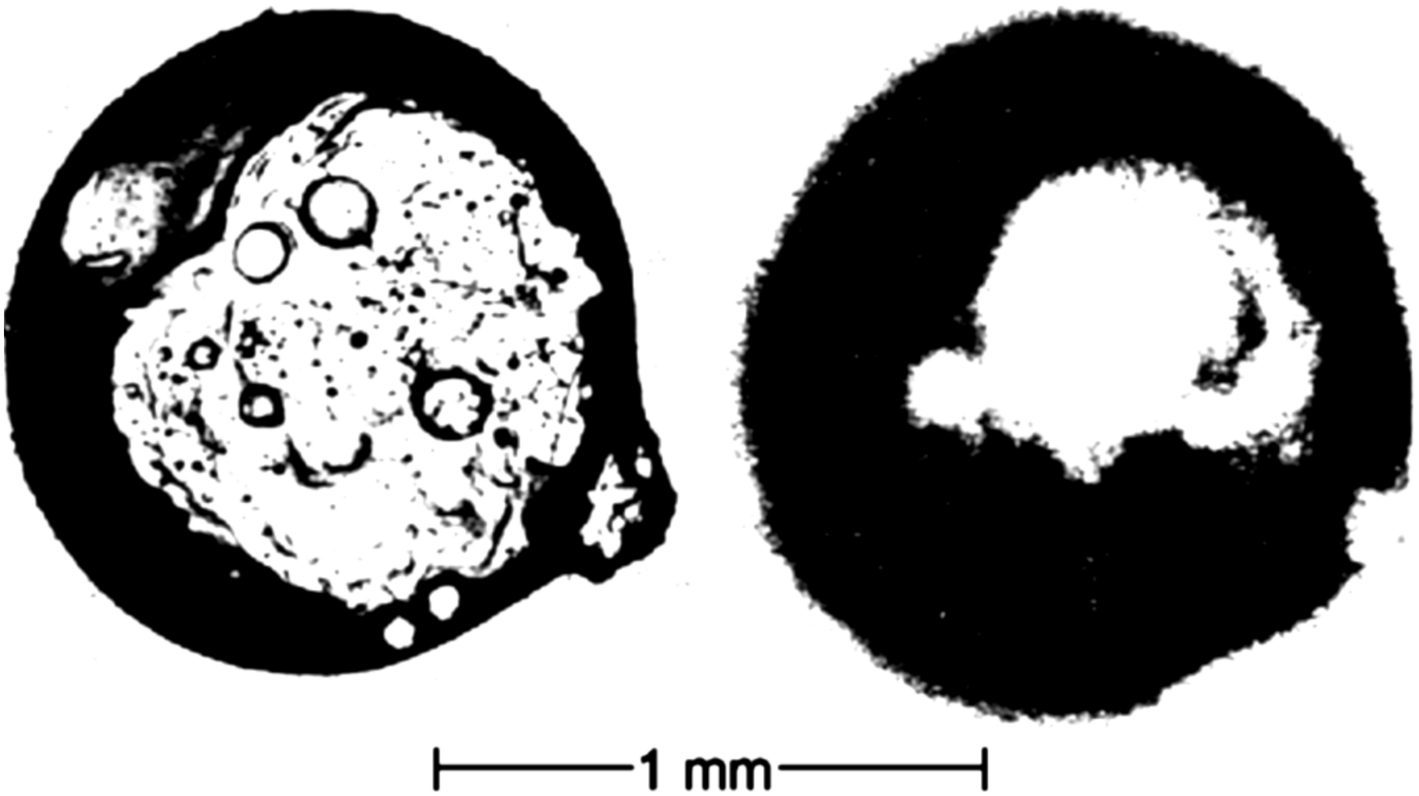
TWO FALLOUT PARTICLES FROM A TOWER SHOT AT THE NEVADA TEST SITE. THE PARTICLE ON THE LEFT IS A PERFECT SPHERE WITH A HIGHLY GLOSSY SURFACE; THE ONE ON THE RIGHT HAS MANY PARTIALLY-ASSIMILATED SMALLER SPHERES ATTACHED TO ITS SURFACE. BOTH PARTICLES ARE BLACK AND MAGNETIC AND HAVE A SUPERFICIAL METALLIC APPEARANCE.



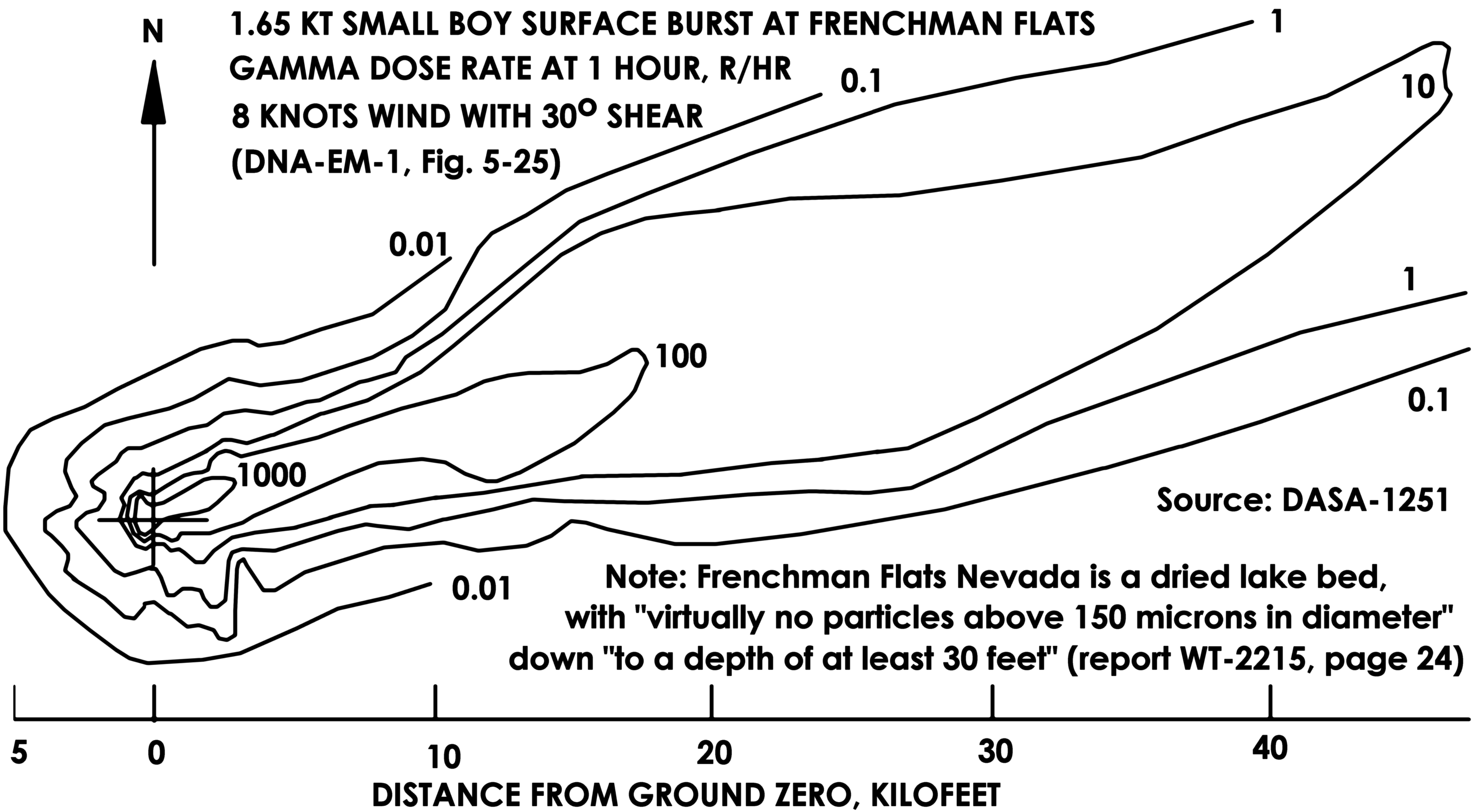
Shiny black marble (iron oxide in glass)



THIN SECTION AND RADIOGRAPH OF A FALLOUT PARTICLE FROM A MODERATE-YIELD TOWER SHOT AT THE NEVADA TEST SITE. THIS PARTICLE IS COMPOSED OF A TRANSPARENT GLASS CORE WITH A DARKLY COLORED IRON OXIDE GLASS OUTER ZONE. MOST OF THE RADIOACTIVITY IS CONCENTRATED IN THE OUTER ZONE

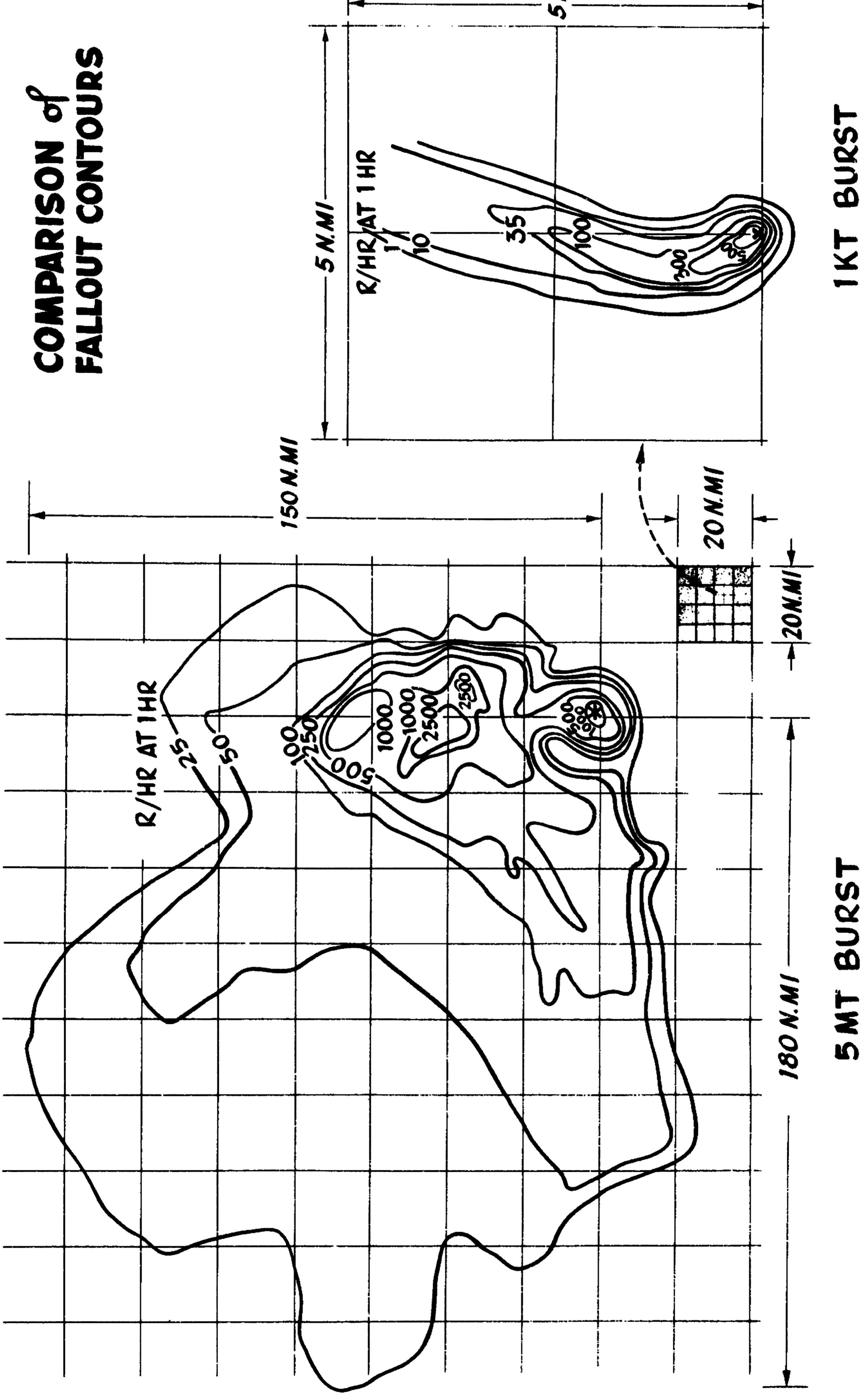


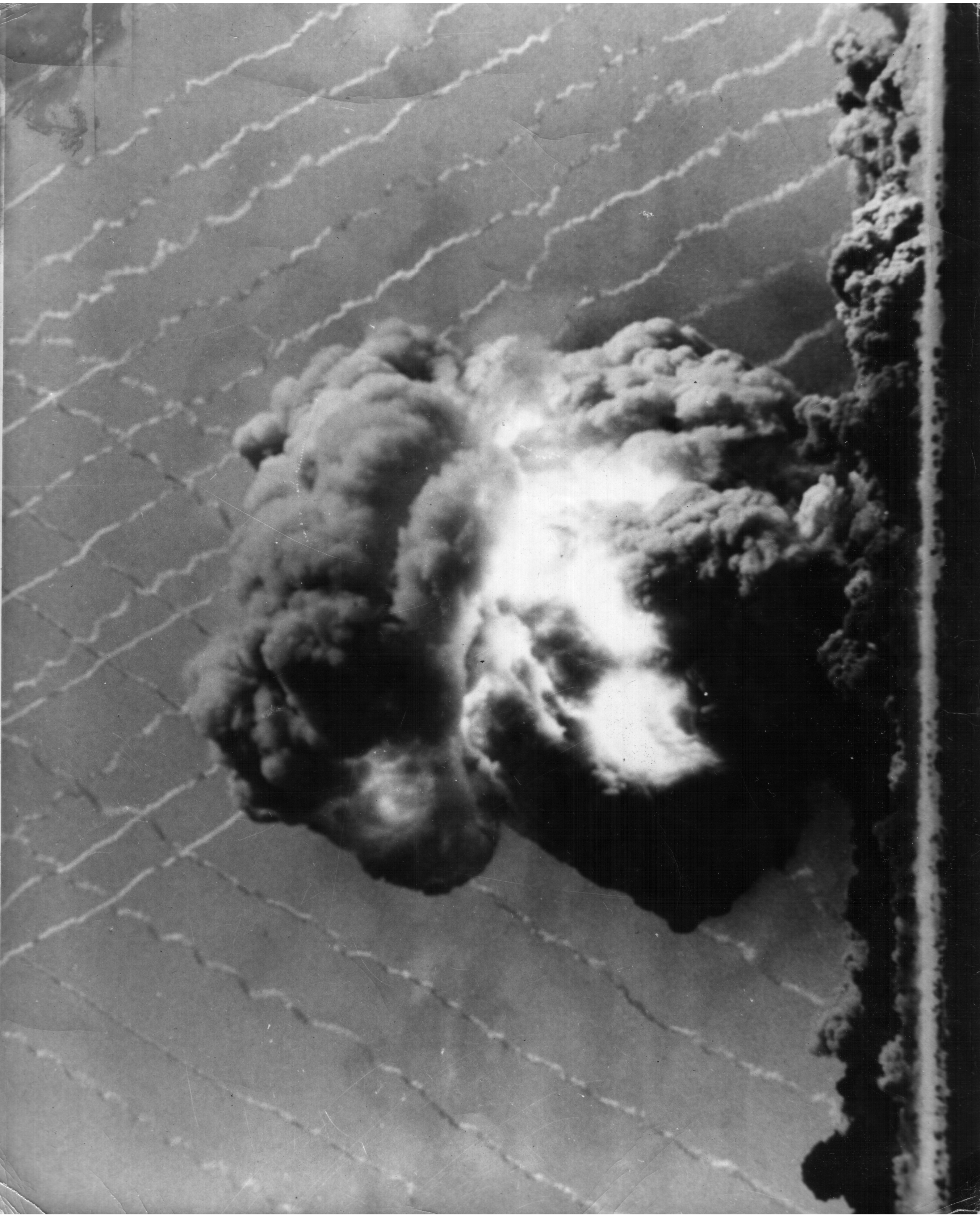
C.E. Adams. The Nature of Individual Radioactive Particles. IV. Fallout Particles From A.B.D. of Operation UPSHOT-KNOTHOLE. U.S. Naval Radiological Defense Laboratory Report, USNRDL-440, February 24, 1954



N
1.65 KT SMALL BOY SURFACE BURST AT FRENCHMAN FLATS
GAMMA DOSE RATE AT 1 HOUR, R/HR
8 KNOTS WIND WITH 30° SHEAR
(DNA-EM-1, Fig. 5-25)
1
0.1
10
0.01
1
100
0.1
1000
Source: DASA-1251
0.01
Note: Frenchman Flats Nevada is a dried lake bed,
with "virtually no particles above 150 microns in diameter"
down "to a depth of at least 30 feet" (report WT-2215, page 24)
5
0
10
20
30
40
DISTANCE FROM GROUND ZERO, KILOFEET

1.2 kt SUGAR (1951) and 5.01 Mt TEWA (87% fission)



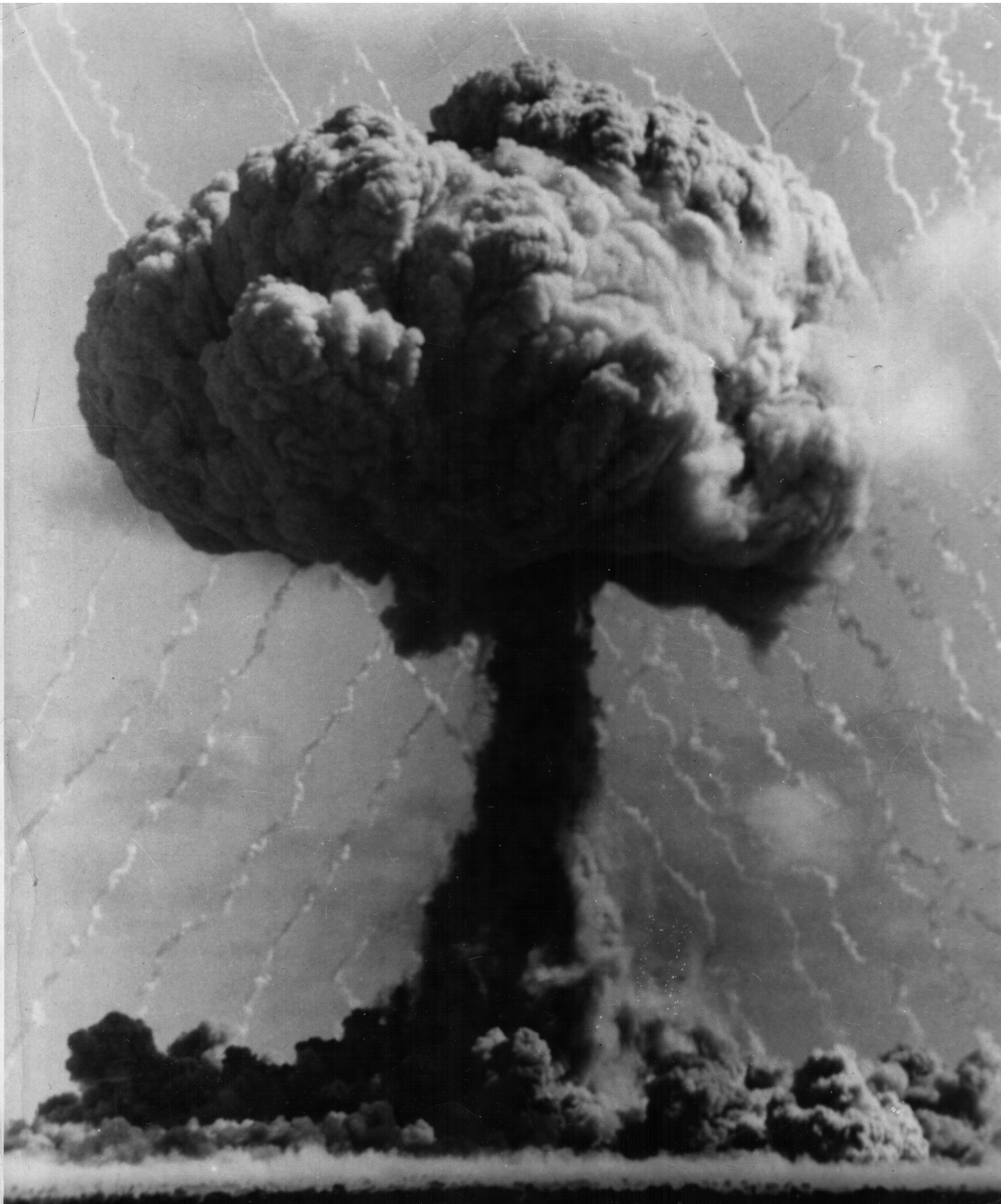


Buffalo-1 at Maralinga, 1956. This nuclear test gave immense civil defence data.

Car (Land Rover jeep) in Maralinga desert, 600m from 15kt Buffalo-1 nuclear test

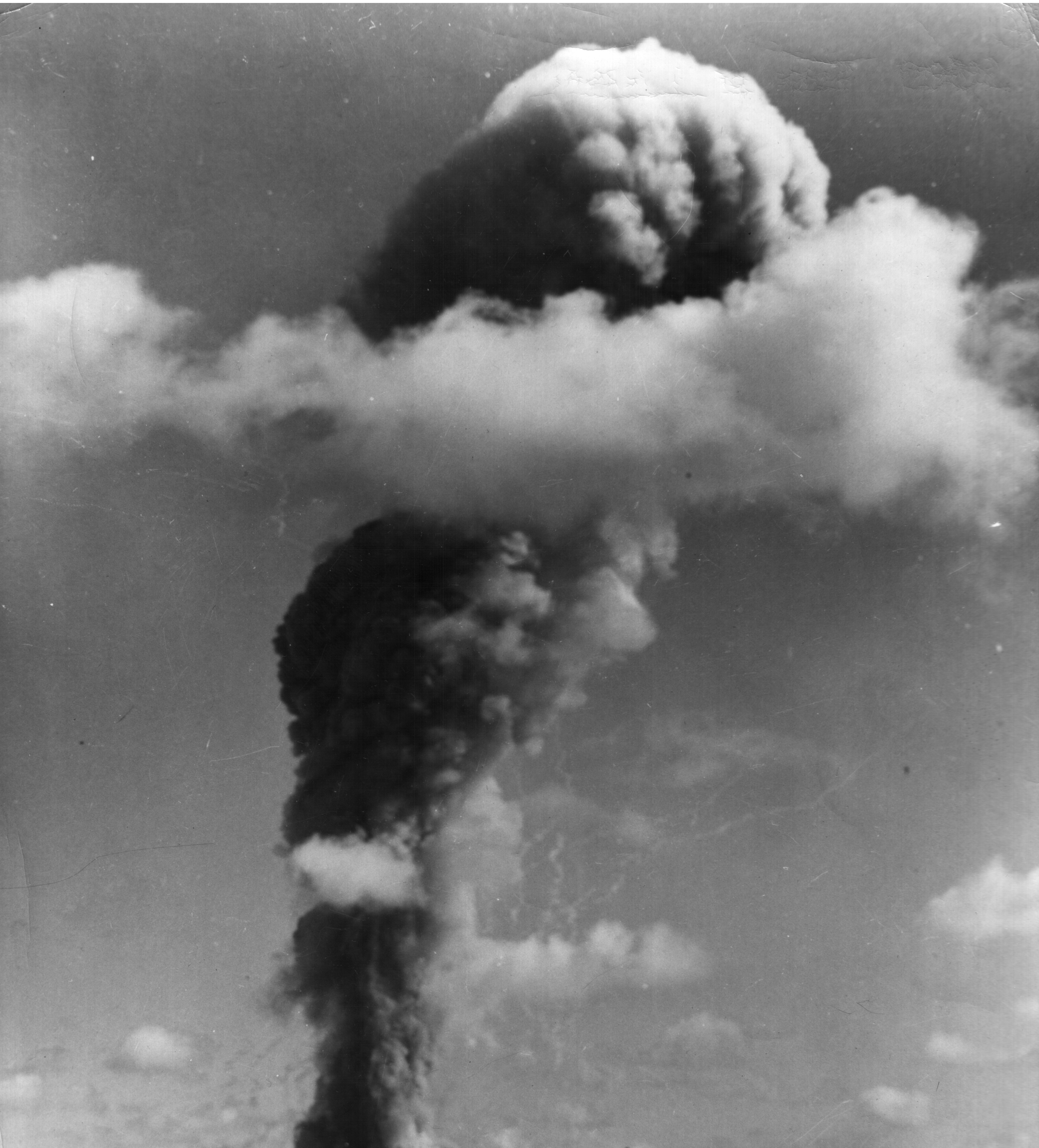
Blast precursor effect on car

Buffalo-1 at Maralinga, 1956. This nuclear test gave immense civil defence data.

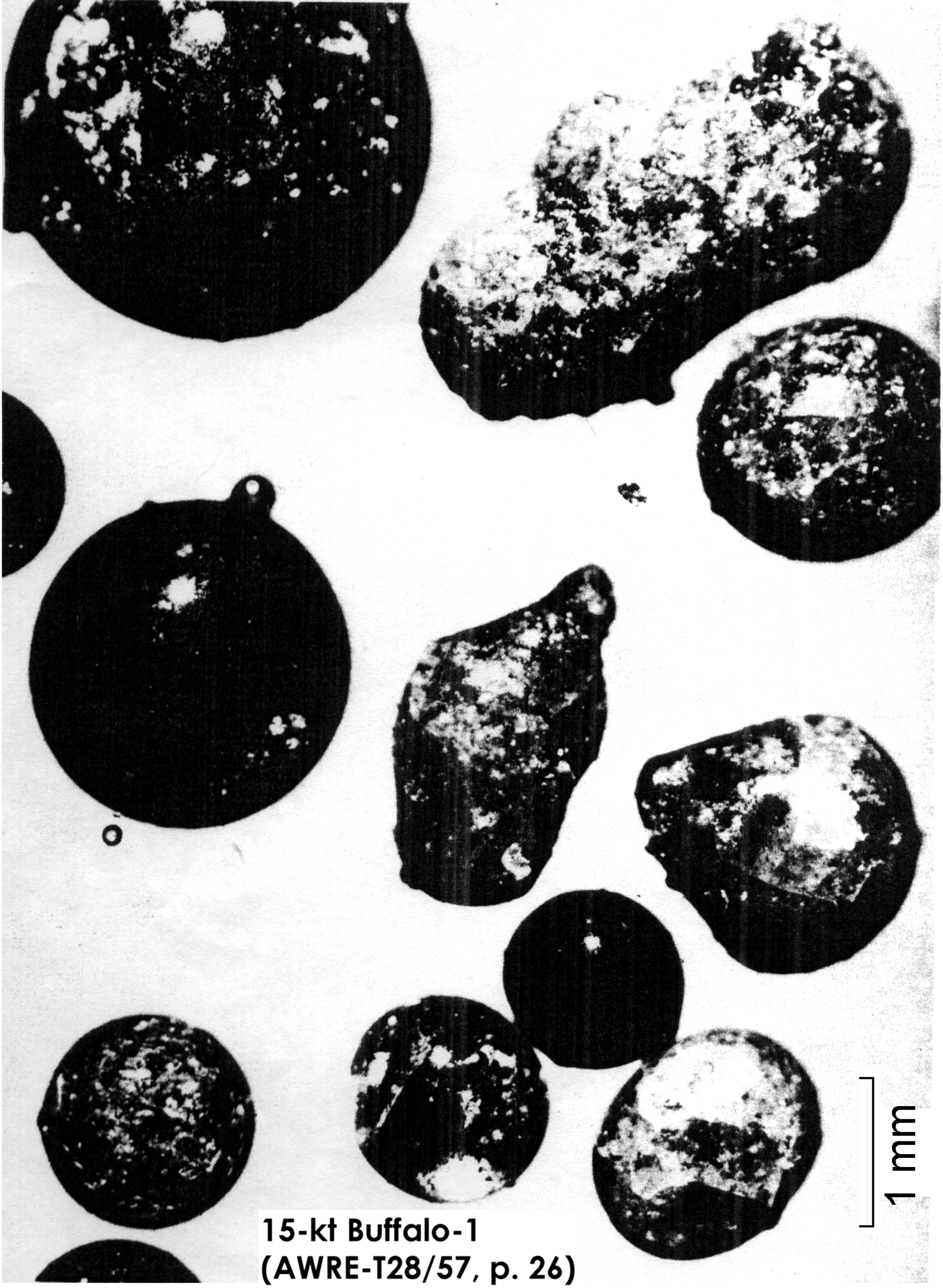


Buffalo-1 vortex cloud forming as cooling fireball rises

Buffalo-1 nuclear test cloud reaching maximum altitude



Buffalo-1 nuclear test being dispersed by winds



NOT AN INVISIBLE GAS: FALLOUT FROM BUFFALO-1
Fallout from sandy soil was glassy marbles.

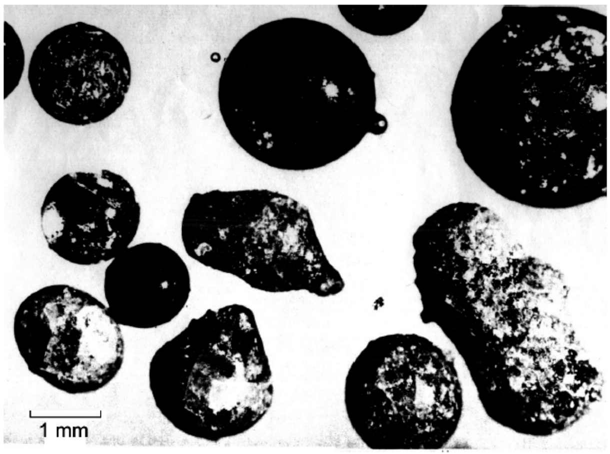
THE VISIBLE CONTAMINANT: SEEING FALLOUT

'Perhaps the most important application of radiological warfare would be its psychological effect as a mystery weapon, analogous to the initial use of poison gas and of tanks in World War I. The obvious method to combat radiological warfare in this case is to understand and be prepared for it.' – Dr Samuel Glasstone, Editor, *The Effects of Atomic Weapons,* Los Alamos Scientific Laboratory, September 1950, p. 289.

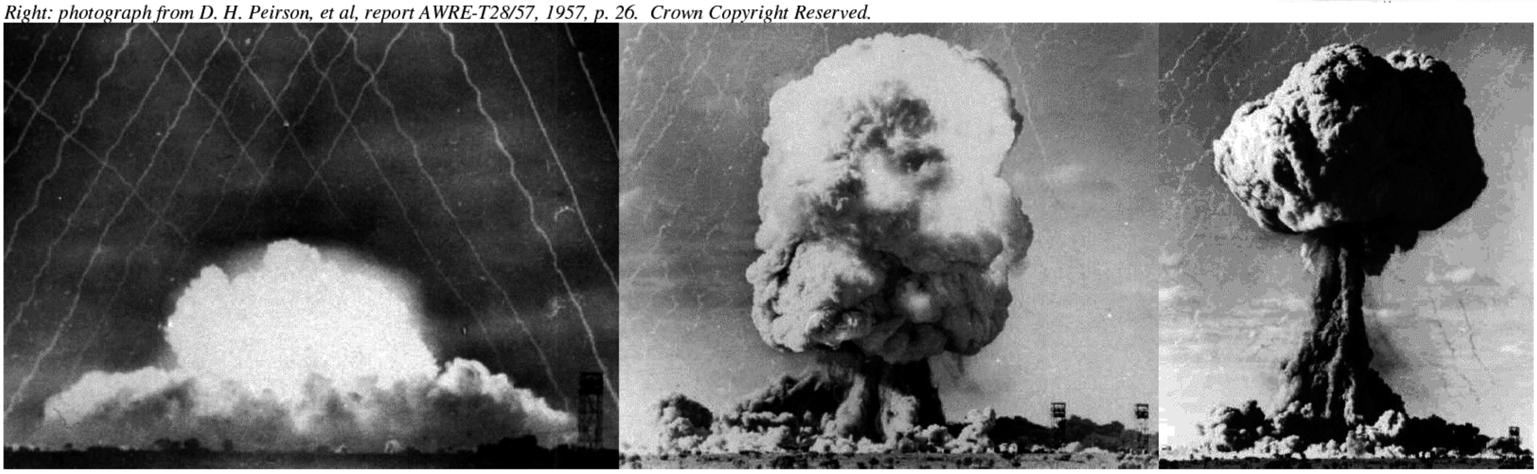
'Sampling stations were located … aboard anchored barges, type YFNB, and manned ships … Particles collected in the incremental type of collector were used … particles could be classified by time of arrival. One of the ship sampling stations was connected by an elevator device to a radiation-shielded laboratory, permitting almost immediate examination of fallout samples.' – N.H. Farlow and W.R. Schell, U.S. Naval Radiological Defense Laboratory, technical report USNRDL-TR-170, 1957, p. 1.

Right: according to the popular superstition, you cannot *see, smell, hear*, or *feel* dangerous fallout, which is an invisible, mysterious, supernatural, all-pervading, fearful, death-ray weapon. This fiction came from two types of anti-nuclear propaganda: the first type confusing particles of radiation with particles of fallout, and the second type concerning the insignificantly radioactive (compared to background radiation), distant fallout from nuclear testing in the 1950s. The fact that data on the dangerous close in fallout was classified 'secret' did not help. The clearly visible nature of dangerous local fallout from the 15 kt Australian-British *Buffalo – One Tree* nuclear test (detonated on a 30.5 m high aluminium tower at Maralinga in Australia on 27 September 1956) is shown on the right. You can see this fallout forming in the fireball vortex photographs below.

The fallout consists of a mixture of large, smooth, globular, glossy, spherical particles resulting from the solidification of melted silicate sand with molten aluminium oxide from the tower, and a variety of unmelted, irregular sand grains. You can *hear* this dangerous fallout hitting surfaces and bouncing. You can also *see, touch,* and *feel* the particles where there is an acute threat to life, but you will not smell them (because of gravity, the fallout particles do not tend to enter your nose!). The melted particles are contaminated with insoluble activity trapped throughout their fused volume. Contamination on unmelted particles is limited to the surface, but is relatively soluble.

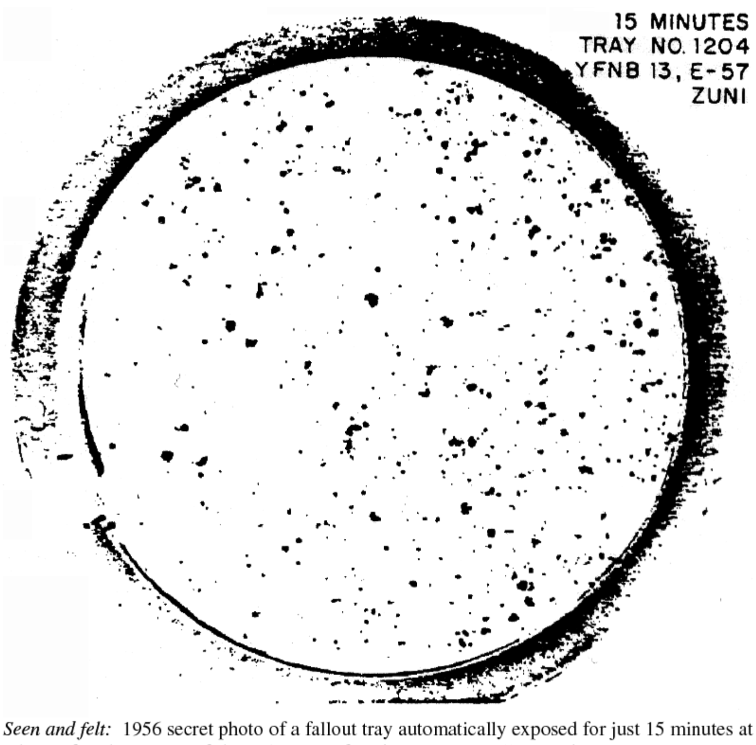


Right: photograph from D. H. Peirson, et al, report AWRE-T28/57, 1957, p. 26. Crown Copyright Reserved.

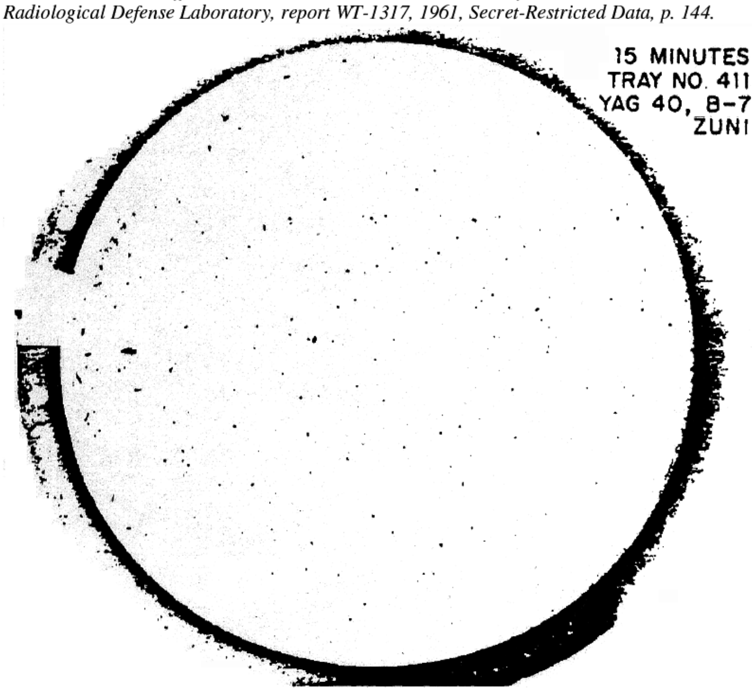


Above: fallout creation at 1, 8, and 20 seconds after detonation of the Australian-British 15 kt burst on a tower 30.5 m high, *Buffalo – One Tree,* at Maralinga, 27 September 1956. The turbulent mixing of sand and gas in the vortex fireball are clearly visible in the dry atmosphere, forming the mixture of fallout particles seen in the photograph above. The background grid of smoke trails seen at 1 second was laid down well behind the fireball by rockets fired about 8 seconds before detonation, specifically to make the shock front visible in films. The shock makes smoke trails appear to 'break' (just an illusion caused by the optical refraction of light in the compressed air of the shock front).

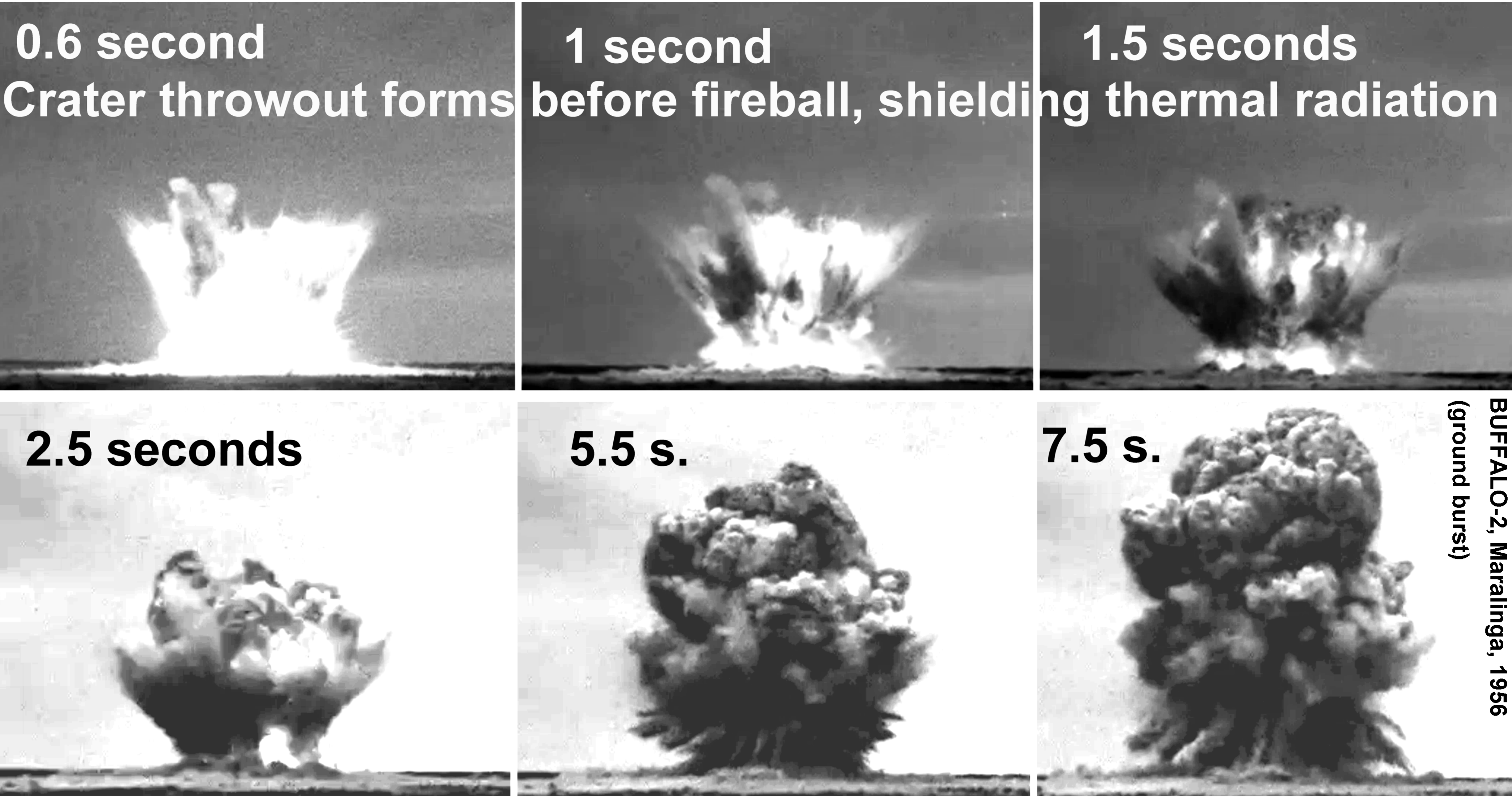
Below and left: *T. Triffet & P. D. LaRiviere, 'Characterization of Fallout,' U.S. Naval Radiological Defense Laboratory, report WT-1317, 1961, Secret-Restricted Data, p. 144.*



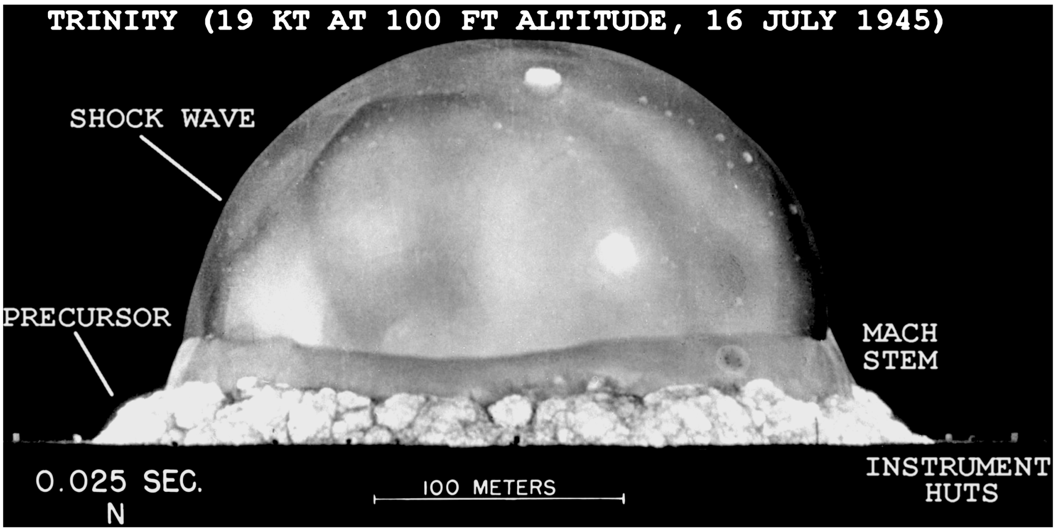
Seen and felt: 1956 secret photo of a fallout tray automatically exposed for just 15 minutes at 1 hour after detonation of the 3.53 Mt surface burst *Zuni*. Fallout on barge YFNB 13, at 20 km North-North-West of ground zero (downwind). The tray's inner diameter is 8.1 cm. This sample is only 22% of the total deposit of 21.9 g/m^2 at that location. The barge's radiation meter recorded a peak gamma intensity of 6 R/hr at 1.25 hours.



Seen and felt: 1956 secret photo of a fallout tray automatically exposed for just 15 minutes at 6 hours after detonation of the 3.53 Mt surface burst *Zuni.* Fallout on ship YAG 40, at 97 km North of ground zero (downwind). The tray's inner diameter is 8.1 cm. This sample is only 12% of the total deposit of 14.1 g/m^2 at that location. The ship's radiation meter recorded a peak gamma intensity of 7.6 R/hr at 6.7 hours.



Afterwinds immediately suck in base surge dust from throwout


TRINITY (19 KT AT 100 FT ALTITUDE, 16 JULY 1945)
SHOCK WAVE
PRECURSOR
MACH STEM
0.025 SEC.
N
100 METERS
INSTRUMENT HUTS


PRECURSOR DUST CLOUD ABSORBS FIREBALL BASE HEAT FLASH
1.0 SEC.
N
100 METERS


TOWER BASE, 1.4 R/HOUR
11 SEPTEMBER 1945

BROOKHAVEN NATIONAL LABORATORY BNL 917 (C-43)

ECOLOGICAL EFFECTS OF NUCLEAR WAR

*Proceedings of a Symposium**
Sponsored by

THE ECOLOGICAL SOCIETY OF AMERICA

at the
Thirteenth Meeting of

THE AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

Amherst, Massachusetts

August 1963

Physical Damage From Nuclear Explosions

CARL F. MILLER
Stanford Research Institute, Menlo Park, California

(pages 1-10)

Table 2

Survival Rates at Hiroshima and Nagasaki

Exposure	Condition	% Survival
50-100 cal/cm^2	Outside	0
	Indoors or shielded	90-100
4-6 psi	Outside	0
	In frame building	85-90
	In concrete building	95-100
	In underground shelter	100

The large particles contributing to local fallout consist mainly of fused and sintered grains of soil minerals. Fused particles are spherical, glassy beads and are usually the most highly radioactive. While in a fluid state in the fireball, these particles incorporate a large fraction of the least volatile fission products into a glassy matrix where such fission products are fixed. As the particles cool in the fireball and become viscous, the more volatile fission products (or their daughter products) collect on their surfaces. In this way, the larger of the fallout particles, those first ejected from the fireball, have radionuclide compositions enriched with the least volatile fission products, i.e., volatile element concentration is lowest. The smaller fallout particles, which remain in the rising cloud the longest, have radionuclide compositions enriched in the volatile elements.

Table 3

Contamination Factor, a_L,* for Crops

Romney, E.M., Lindberg, R.G., Hawthorne, H.A., Bystrom, B.G., and Larson, K.H. 1963. Contamination of plant foliage with radioactive fallout. *Ecology* **44**, 343-9.

Distance from ground zero, miles	Red clover	Alfalfa	Wheat	Mixed grasses
		Apple II Shot (Tower)		
7	5.6×10^{-5} (0.0011)**	–	5.3×10^{-5} (0.0020)	–
48	4.2×10^{-4} (0.0066)	–	6.0×10^{-4} (0.0240)	–
106	8.3×10^{-4} (0.0120)	–	18.0×10^{-4} (0.0580)	–
		Smoky Shot (Tower)		
132	–	2.6×10^{-3} (0.0490)	–	–
259	–	4.2×10^{-3} (0.1170)	–	3.2×10^{-3} (0.0530)

$$*a_L=\frac{\text{gross activity collected per g dry weight of foliage}}{\text{gross activity collected per sq ft of soil area}}=\frac{\text{sq ft of soil area}}{\text{g dry foliage}}.$$

**Values in parentheses are the fractions retained; they are equal to $a_L w_L$ where w_L is the foliage surface density in grams of dry foliage per sq ft of soil area.

Table 4

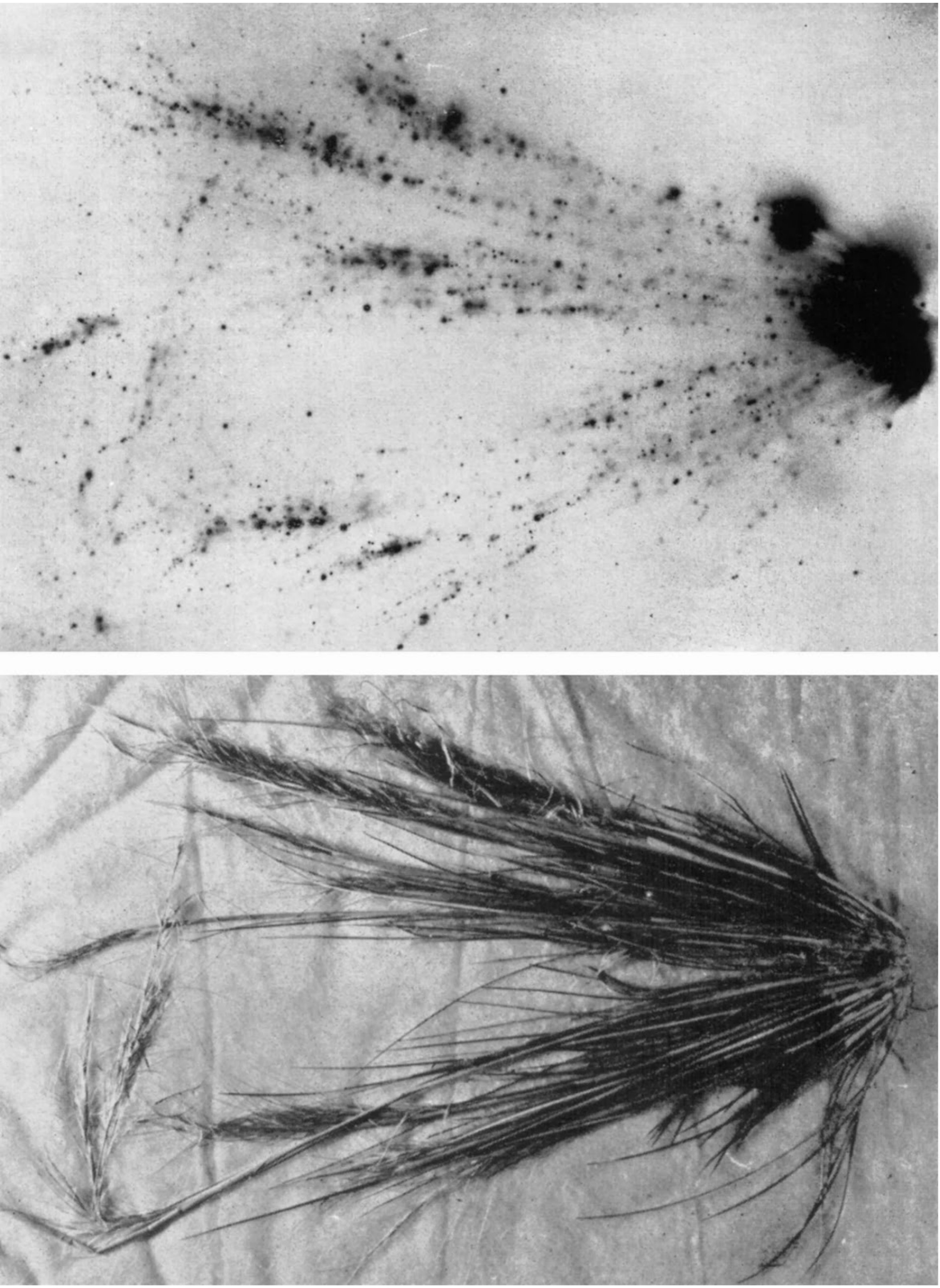
Russell, R.S. and Possingham, J.V. 1961. Physical characteristics of fallout and its retention on herbage. In *Progress in Nuclear Energy*. Series VI, Biological Sciences, Vol. 3, J.C. Bugher et al., Editors. Pergamon Press, New York. Pp. 2-26. **(AWRE-T-57/58, May 1959.)**

Summary of a_L Values Obtained at Operation Buffalo for Contamination of Rye Grass

Approximate I(max) range, r/h at 1 hr	a_L(av), $\frac{\text{sq ft of soil area}}{\text{g foliage}}$	$a_L w_L$*
0.07–0.15	6.8	0.15
0.15–0.30	7.1	0.16
0.30–0.60	5.9	0.13
0.60–1.00	2.7	0.06
1.00–2.00	4.0	0.09
2.00–5.00	2.9	0.07
5.00–9.00	1.4	0.03

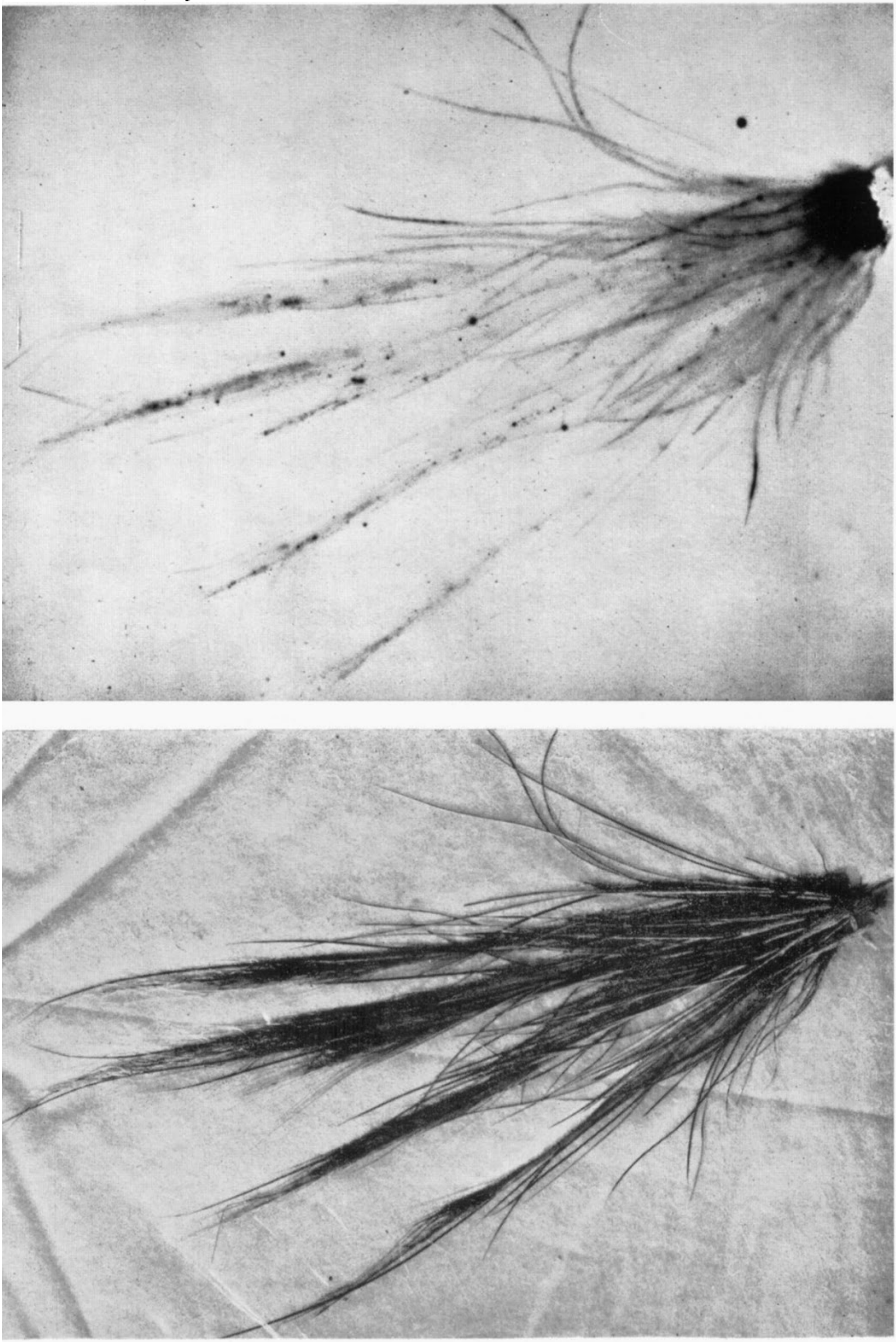
*Where $w_L = 22.3$ g foliage/sq ft of soil area (height of grass $=0.33$ ft).

Ryegrass (Lolium perenne) after 15 kt Buffalo-1 tower shot at Maralinga



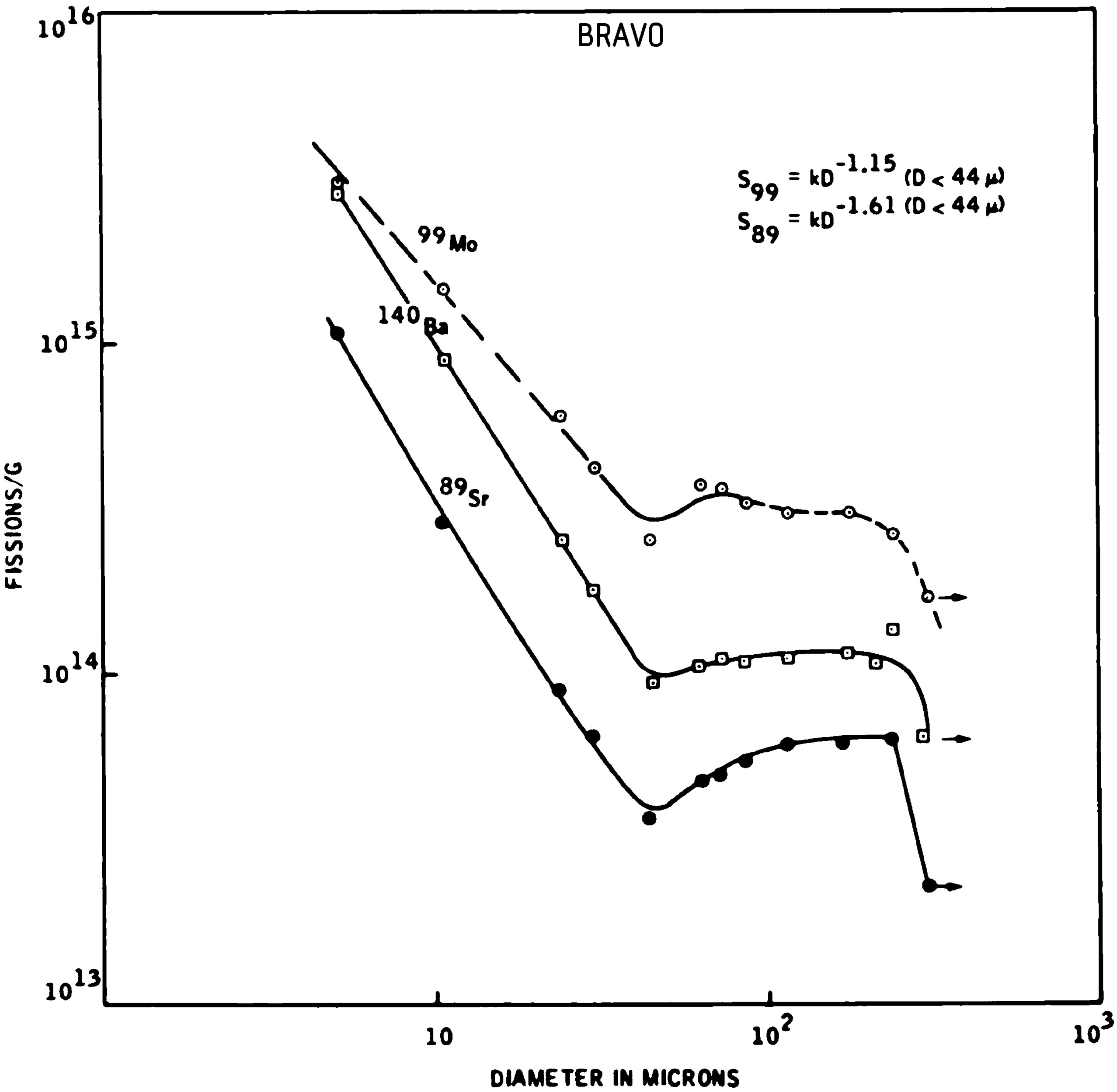
Little dry surface burst silicate fallout is retained

AWRE-T-57/58, May 1959



Ryegrass (Lolium perenne) after 1.5 kt Buffalo-2 surface shot at Maralinga, after 2 cm rain

Morgenthau, M., H. E. Show, R. C. Tompkins, and P. W. Krey.
1960. Land fallout studies. Defense Atomic Support Agency Rep.
WT-1319. Washington, D.C.



Specific activity of fallout as function of particle diameter

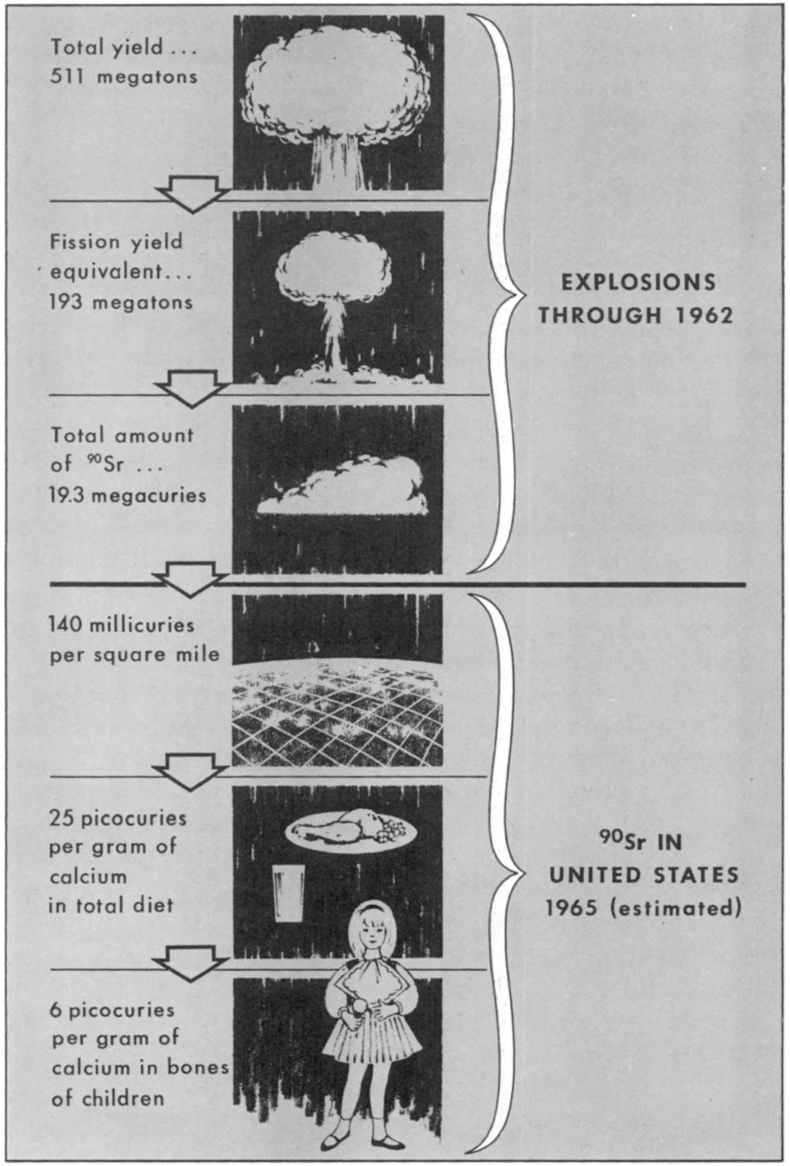
(Equivalent fissions $\times 10^{-14}$ per gram)

$D_g(\mu)$	ZUNI 3.5 Mt (Prompt Fallout near Ground Zero)	ZUNI 3.5 Mt (Fallout Collected 80 km Downwind)	TEWA near ground zero 5.1 Mt	15 Mt BRAVO (Radioactive Particles Only, Shot Atoll, Spheres plus Irregulars)	LACROSSE 0.04 Mt (All Particles, Shot Atoll, Spheres plus Irregulars)
Chain 99 (^{99}Mo)					
57	4.8	16.0	10.2	7.2	2.5
88	4.9	10.6	8.9	6.6	4.0
125	5.8	9.8	8.4	6.2	4.7
177	6.0	12.5		6.0	5.7
297	12.4	13.2		4.8	4.5
594	11.9	21.3		3.4	1.6
840	3.1	24.3		–	–
Chain 89 (^{89}Sr)					
57	0.075	0.24	0.36	0.086	0.063
88	0.065	0.17	0.28	0.11	0.074
125	0.046	0.19	0.24	0.12	0.082
177	0.042	0.14		0.12	0.062
297	0.043	0.12		0.13	0.044
594	0.044	0.11		0.046	0.063
840	0.075	0.070		–	–
Chain 140 (^{140}Ba)					
57	0.32	1.28	0.67	0.20	0.25
88	0.27	0.74	0.54	0.22	0.28
125	0.20	0.99	0.45	0.22	0.30
177	0.17	0.77		0.23	0.23
297	0.15	0.75		0.25	0.18
594	0.16	0.67		0.13	0.24
840	0.031	0.41		–	–

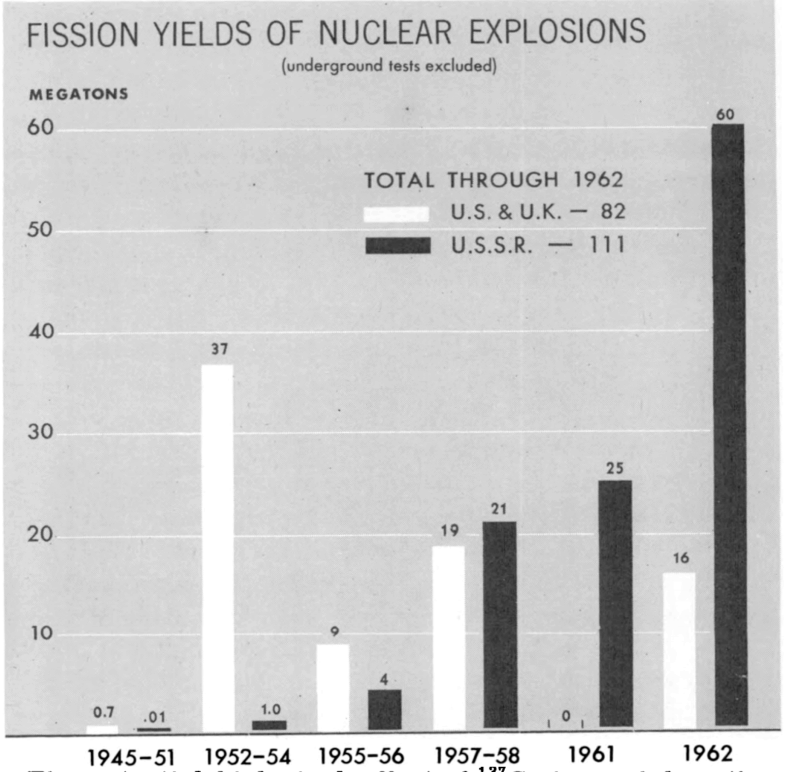
Morgenthau, M., H. E. Show, R. C. Tompkins, and P. W. Krey. 1960. Land fallout studies. Defense Atomic Support Agency Rep. WT-1319. Washington, D.C.

Fall out from nuclear tests, by C. L. Comar (U.S. Atomic Energy Commission, Understanding the Atom series, revised edition, 1966)

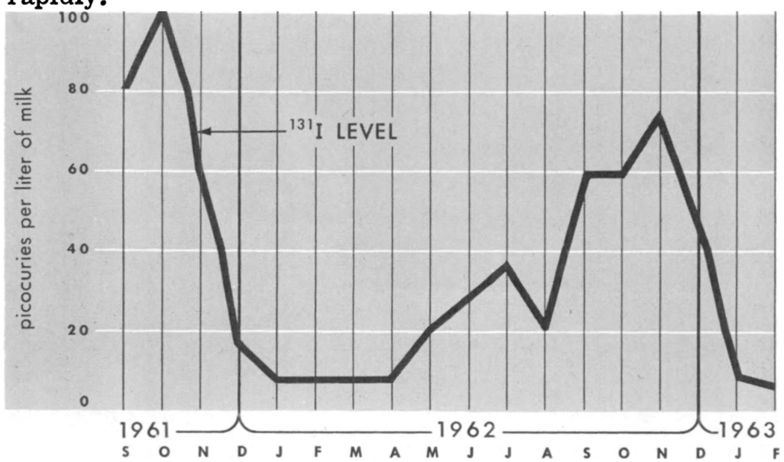
PAST EXPLOSIONS AND STRONTIUM-90 LEVELS



FISSION YIELDS OF NUCLEAR EXPLOSIONS



The potential biological effect of ^{137}Cs is much less than that of ^{90}Sr because ^{137}Cs is removed from the body more rapidly.



Remedial measures for ^{131}I are relatively simple because of its short half-life, and because it reaches the public primarily in a single identifiable food, milk.

Measures proposed to be put into effect should ^{131}I in milk reach stipulated levels are:

(a) *Use of stored feed instead of pasture for dairy cows.*

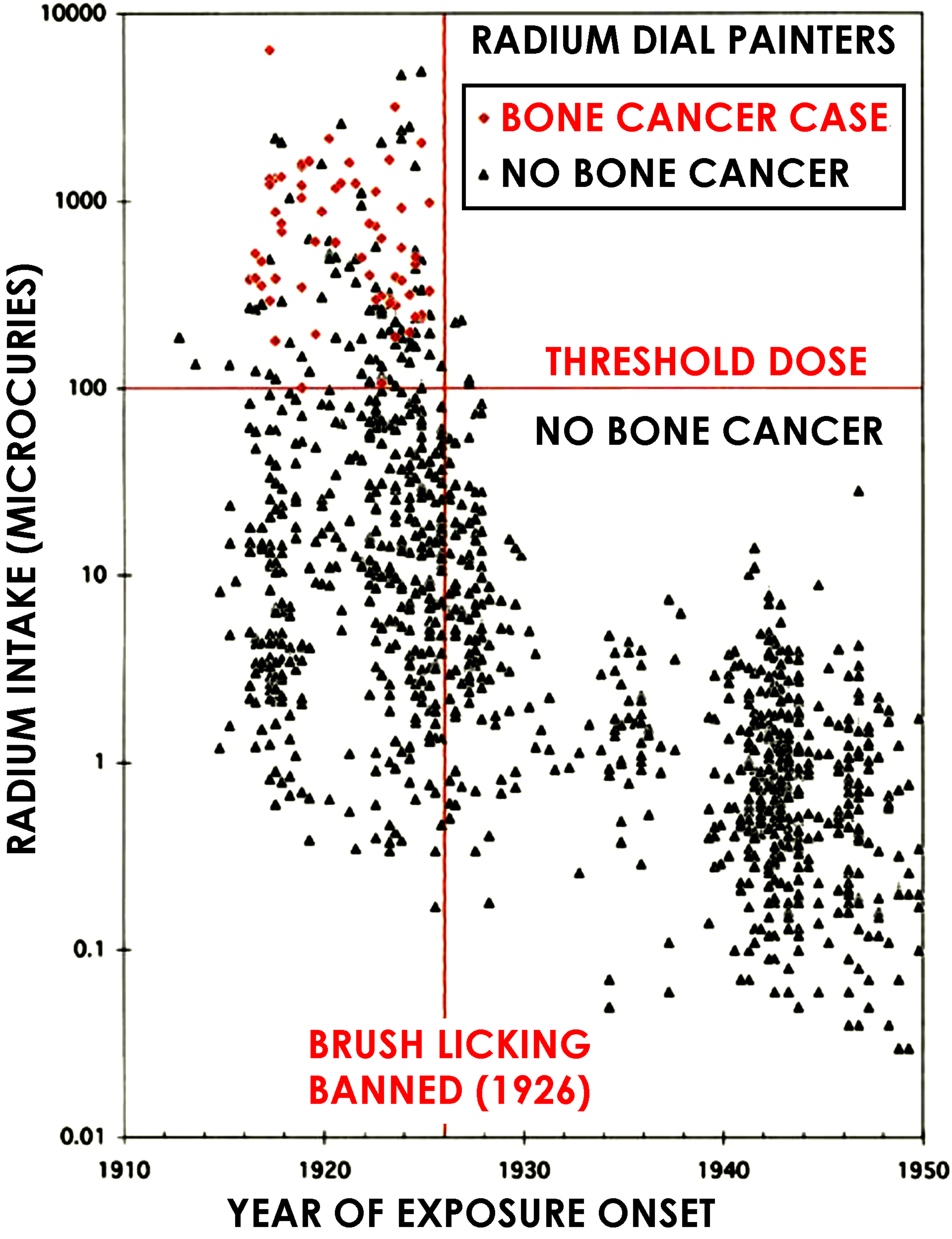
(b) *Use of evaporated or powdered milk for young children and pregnant and lactating women.*

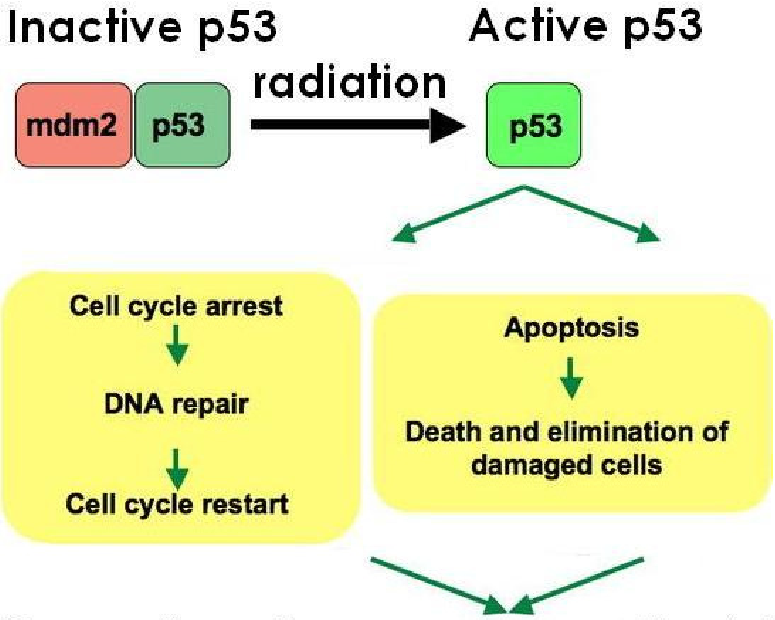
(c) *Use of stored milk products.*

Addition of stable iodine to human diet.

Cyril L. Comar is professor of physical biology at Cornell University and has acted as consultant and advisor to many national and international committees

Rowland, R. E. Radium in Humans: A Review of U. S. Studies, Argonne National Laboratory (1994).





Prevention of cancer or genetic defect
at low dose rates (at high dose rates, double strand DNA breaks are too rapid)

Dr C. Sanders, Radiation Hormesis and the LNT Assumption, Springer, 2010

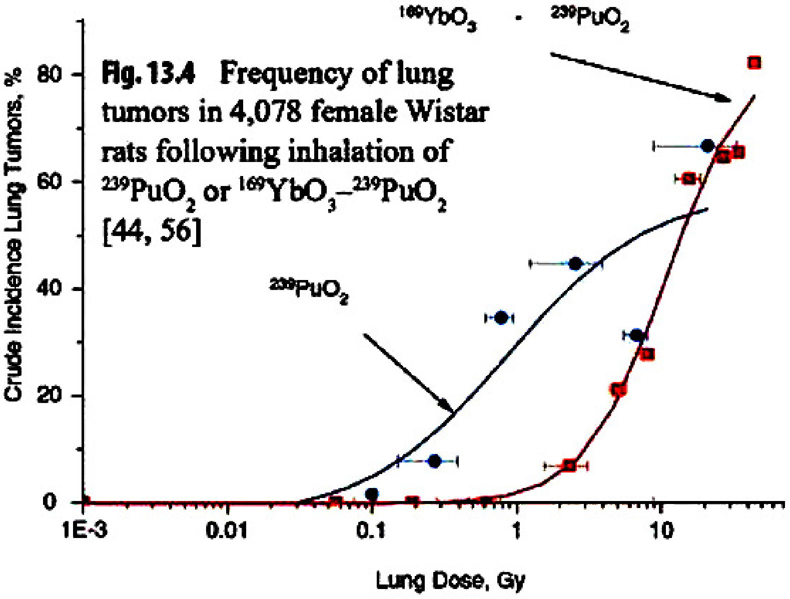
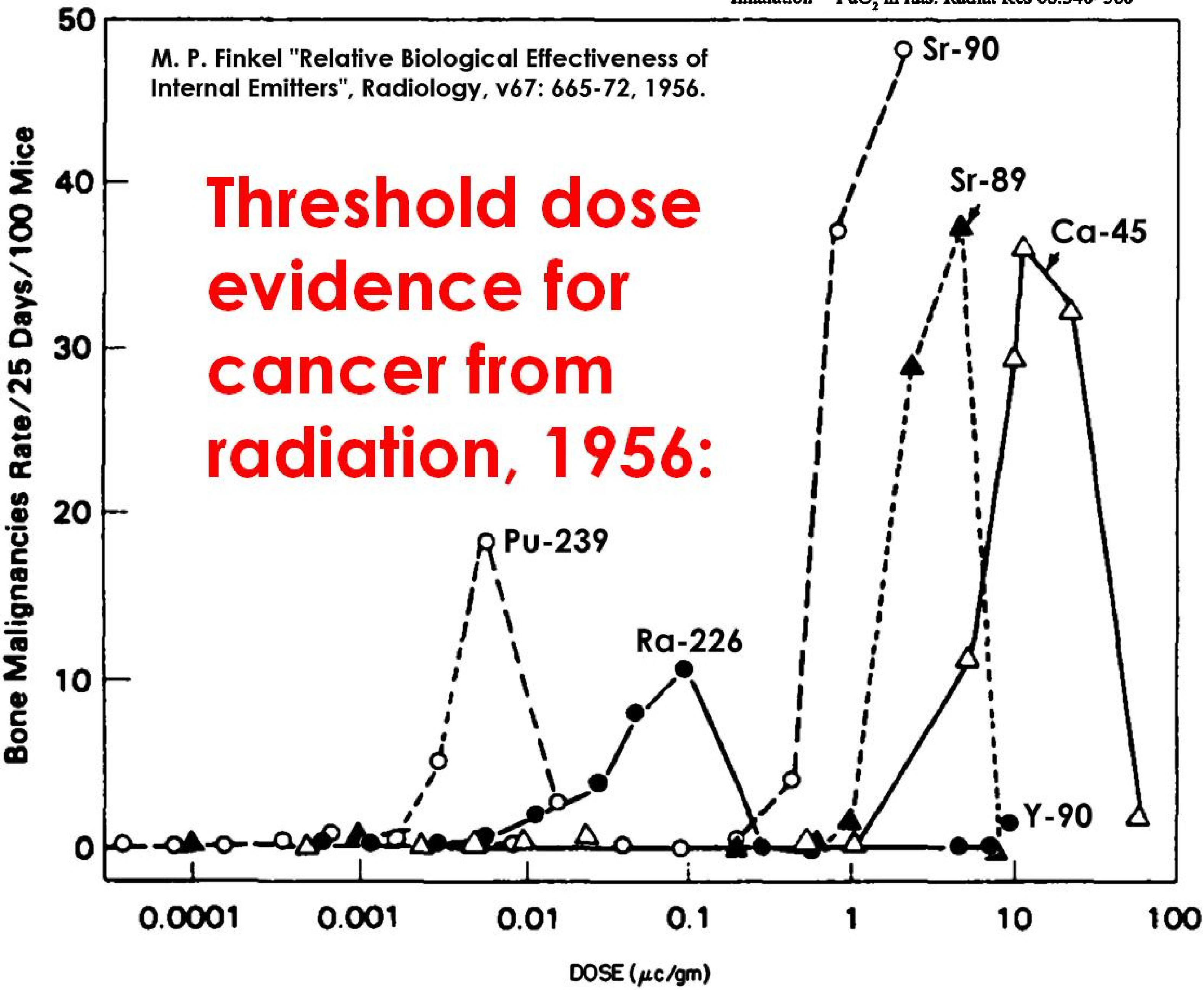


Fig. 13.4 Frequency of lung tumors in 4,078 female Wistar rats following inhalation of $^{239}PuO_2$ or $^{169}YbO_3$–$^{239}PuO_2$ [44, 56]

44. Sanders CL, Lauhala KE, McDonald KE (1993) Lifespan studies in rats exposed to $^{239}PuO_2$ aerosol. III. Survival and lung tumors. Int J Radiat Biol 64:417–340

56. Sanders CL, Dagle GE, Cannon WC et al (1976) Inhalation $^{239}PuO_2$ in rats. Radiat Res 68:340–360



Dose range milli-sievert	Number in 1950	Cancer deaths (excl. leukaemia)		Leukaemia deaths	
		total rate	rate from radiation	total rate	rate from radiation
Less than 100	68467	11.2%	0.09%	0.2%	0.01%
100 to 200	5949	12.3%	0.7%	0.2%	-0.01%
200 to 1000	9806	13.2%	1.9%	0.6%	0.3%
More than 1000	1829	24.1%	8.1%	3.5%	2.4%
All	**86611**	**11.7%**	**0.6%**	**0.3%**	**0.1%**

Cancer deaths among 86611 Hiroshima and Nagasaki survivors, 1950-2000

The total radiation-related deaths from solid cancer and leukaemia were 480 and 93, respectively.

Source: Dr Wade Allison

1 milliSievert = 100 mR

http://www.bioone.org/doi/abs/10.1667/RR3232

Preston, D. L., Pierce, D. A., Shimizu, Y., Cullings, H. M., Fujita, S., Funamoto, S. and Kodama, K., "Effect of Recent Changes in Atomic Bomb Survivor Dosimetry on Cancer Mortality Risk Estimates," Radiat. Res. v162, pp377–389 (2004).

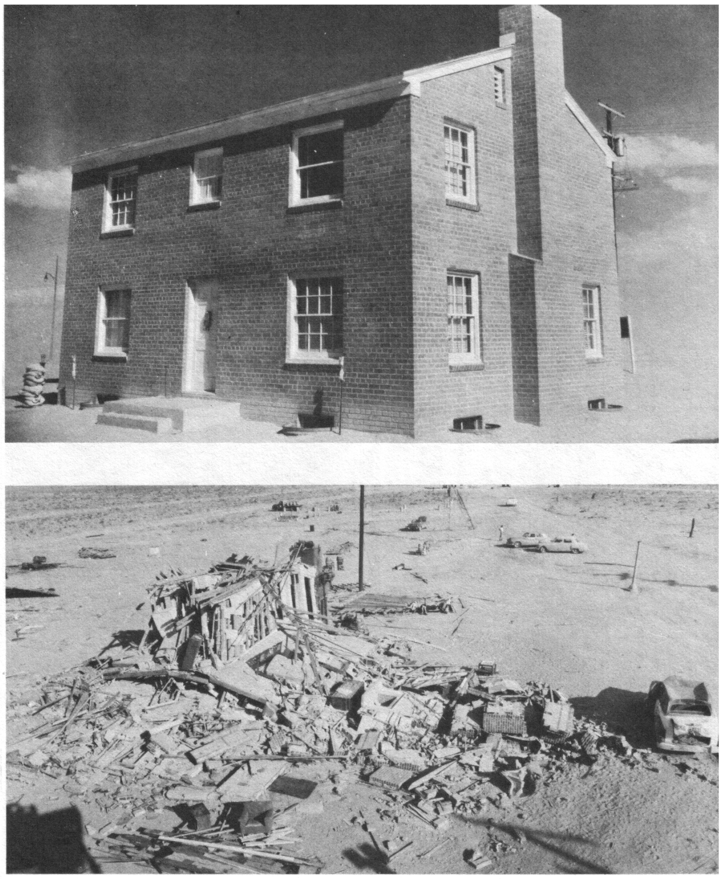
1979 U.S. Office of Technology Assessment, "The Effects of Nuclear War" deceptions

Table 14.—Long-Term Radiation Effects From Nuclear Attacks

Estimated worldwide[b] effects from 1-Mt air burst over a city (OTA Case 1):	
Somatic effects	
Cancer deaths	200 - 2,000
Thyroid cancers	about 700
Thyroid nodules	about 1,000
Genetic effects	
Abortions due to chromosomal damage	100 - 1,000
Other genetic effects	350 - 3,500

[b] Most worldwide fallout would be in the Northern Hemisphere

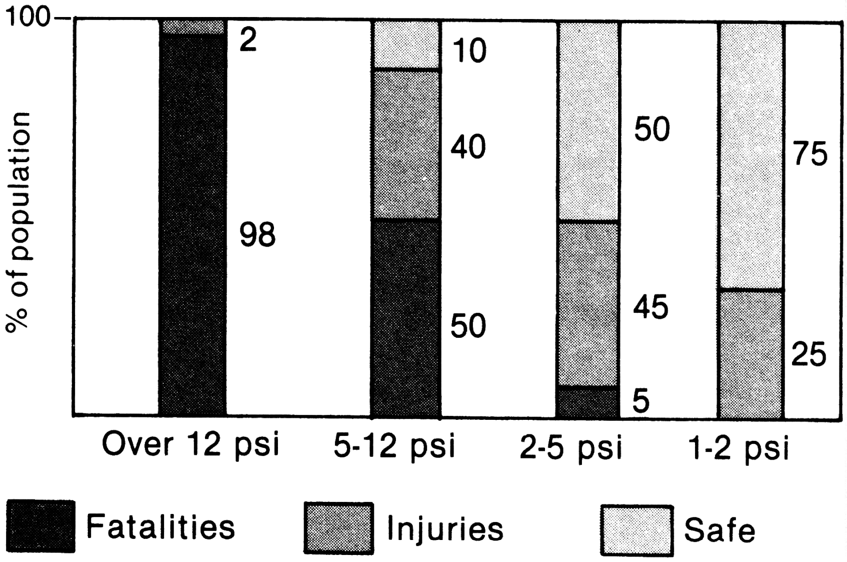
Above: false LNT radiation scaremongering



Damage to unreinforced brick house (5-psi overpressure)

Above: false house collapse (Apple-2 test house after manually demolished!) photo. In fact, outer walls exploded but 1st floor did not collapse at 5 psi, and outward debris motion reduced hazard!

Figure 1.—Vulnerability of Population in Various Overpressure Zones



Blast exaggeration:

Table 4.—Casualty Estimates (in thousands) (1 Mt on Detroit)

Region (mi)	Area (mi²)	Population	Fatalities	Injuries	Uninjured
0-1.7	9.1	70	70	0	0
1.7-2.7	13.8	250	130	100	20
2.7-4.7	46.5	400	20	180	200
4.7-7.4	102.6	600	0	150	450

Exaggerated blast effects table ignores modern city concrete buildings which resist blast collapse

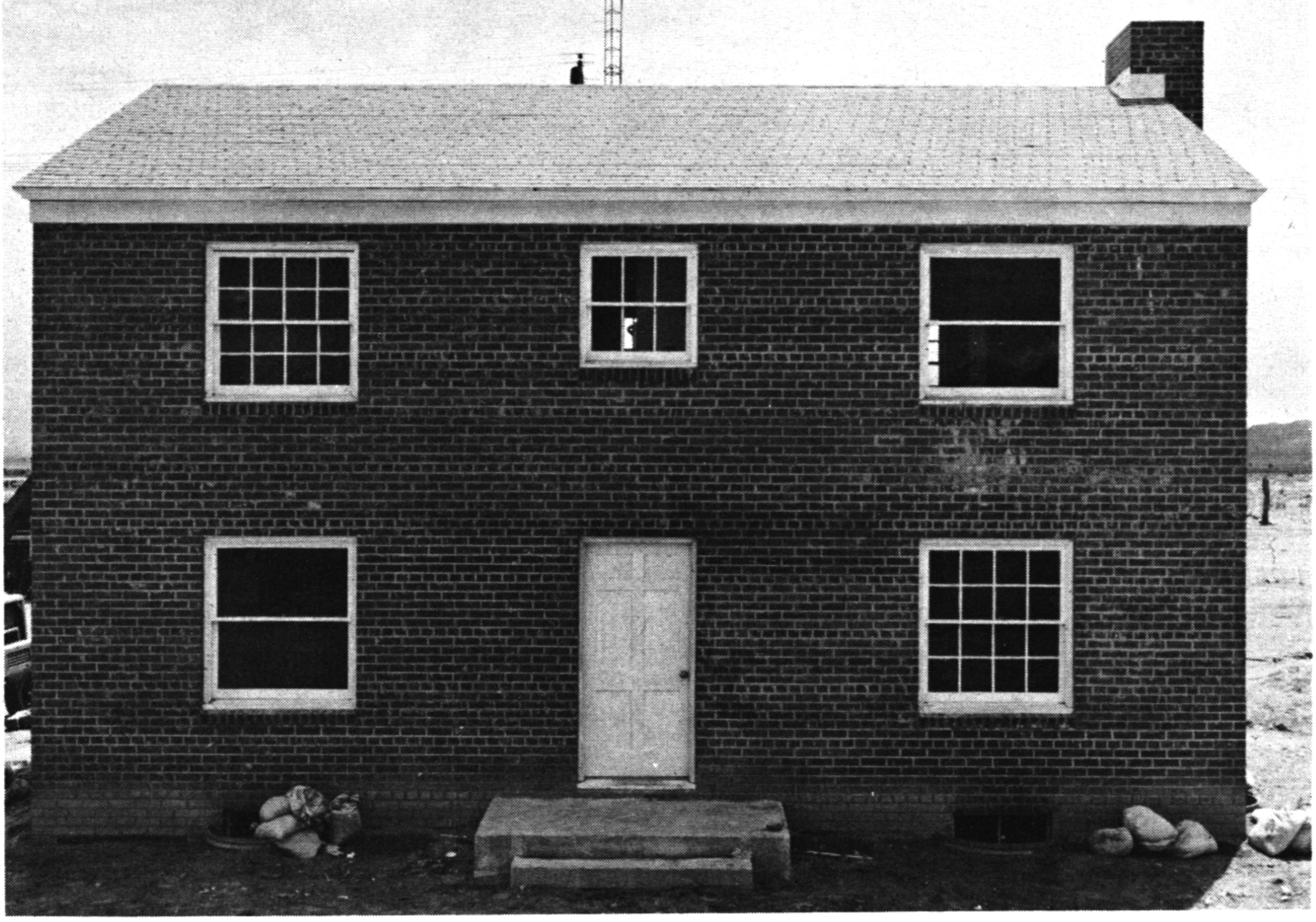
Table 5.—Burn Casualty Estimates (1 Mt on Detroit)

Distance from blast (mi)	Survivors of blast effects	Fatalities (eventual)		Injuries	
		2-mile visibility	10-mile visibility	2-mile visibility	10-mile visibility
(1 percent of population exposed to line of sight from fireball)					
0-1.7	0	0	0	0	0
1.7-2.7	120,000	1,200	1,200	0	0
2.7-4.7	380,000	0	3,800	500	0
4.7-7.4	600,000	0	2,600	0	3,000
Total (rounded)		1,000	8,000	500	3,000
(25 percent of population exposed to line of sight from fireball)					
0-1.7	0	0	0	0	0
1.7-2.7	120,000	30,000	30,000	0	0
2.7-4.7	380,000	0	95,000	11,000	0
4.7-7.4	600,000	0	66,000	0	75,000
Total (rounded)		30,000	190,000	11,000	75,000

These calculations arbitrarily assume that exposure to more than 6.7 cal/cm² produces eventual death, and exposure to more than 3.4 cal/cm² produces a significant injury, requiring specialized medical treatment.

Exaggerated thermal burns table "arbitrarily" assumes 6.7 cal/cm^2 is lethal and 3.4 cal/cm^2 hospitalizes.

This was not true even for light clothing in Hiroshima and for bigger yields even more heat is needed! Skyline shadowing protects over 90%.



29 kt Teapot-Apple 2 test, 5 psi peak overpressure

exterior walls were exploded outward, so that very little masonry debris fell on the floor framing. The roof was demolished and blown off, the rear part landing 50 feet behind the house.

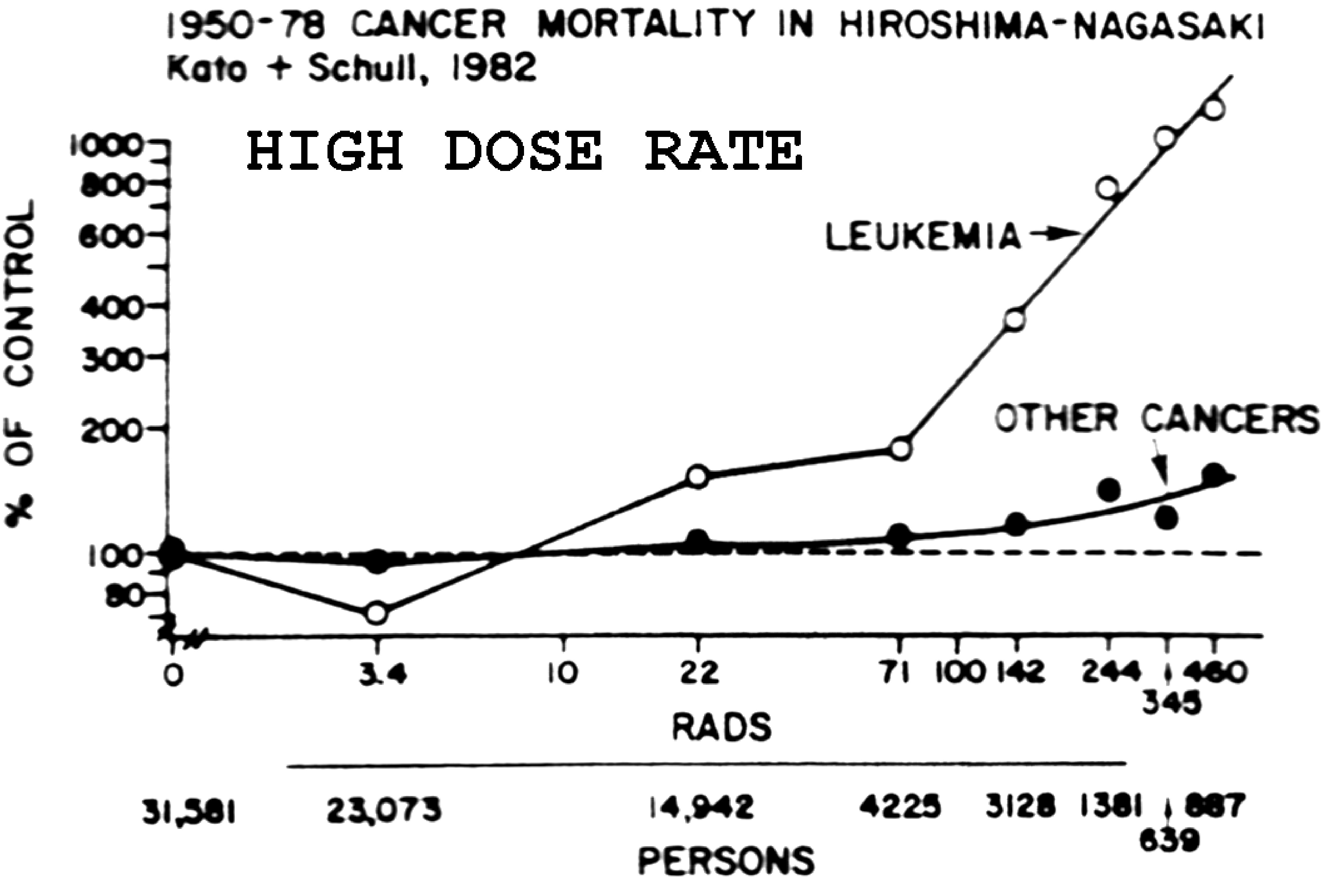
S. Glasstone, Effects of Nuclear Weapons, 1964, p208

Wall brick debris was blown out, not in on to people!





Morrison shelter survives direct hit in York 1942


1950-78 CANCER MORTALITY IN HIROSHIMA-NAGASAKI
Kato + Schull, 1982
HIGH DOSE RATE
% OF CONTROL
1000
800
600
400
300
200
100
80
LEUKEMIA
OTHER CANCERS
0
3.4
10
22
71
100
142
244
345
460
RADS
31,581
23,073
14,942
4225
3128
1381
639
887
PERSONS

HOME OFFICE

CIVIL DEFENCE
TRAINING MEMORANDUM No. 4

The Clearance of Z Zones by Road

(*REVISED* 1965)

(Z Zones are fallout areas where the 48 hour gamma dose rate is above 10 R/hour. This corresponds to a dose rate of 1,000 R/hour or more at 1 hour after a nuclear explosion. The outside dose accumulated from an arrival time of 1 hour after a 1 megaton burst, up to evacuation at 48 hours, is:

$$\text{Dose} = 5 \times 1000 \times (1 - 48^{-0.2}) = 2{,}700 \text{ R outdoors}$$

or 67 R in a brick house's room with blocked windows)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1965

SIXPENCE NET

The Clearance of Z Zones by Road

Introduction

1 This memorandum is concerned with the drill for clearance by road from those parts of a Z Zone which are not in a damaged area. In a damaged area the drill would have to be modified as necessary to meet the special conditions obtaining, e.g. restriction of road access. The memorandum deals only incidentally with the areas to which people will be cleared. It is assumed that 'assembly towns' of, say, from 8,000 to 50,000 population at distances up to about 20 miles from the Z Zone will be selected to receive those cleared; and that the bases from which clearance operations will be mounted will be on the outskirts of those assembly towns commanding main routes into the Z Zone. It may sometimes be desirable to site the clearance bases further forward; in which case staging points will be set up from which people will be transported to the assembly town by train or other means.

2 In clearance the maximum use must be made of all forms of petrol-driven transport, including public transport already within a Z Zone. Families capable of clearing themselves should do so; and wardens should, so far as possible, arrange in advance that spare places are reserved for neighbours. The opportunity should be taken wherever possible to provide for people living in remote areas without their own transport to be collected by private transport on the way out. This will simplify the task of clearance from outside. Instructions to the public will require that houses left completely empty should be marked by the last person to leave by hanging a sheet out of a front window.

3 The proportion of population capable of being moved by transport already in a Z Zone is likely to be substantial but the remainder will have to be cleared by transport sent in from outside.

4 The closest contact will have to be maintained at every level between the warden organisation within the Zone and the clearance forces working from outside. The wardens will be responsible for providing clearance forces with essential information; and, in anticipation of the area coming within a Z Zone, should make the preliminary plans described in Appendix I.

General principles of clearance

5 The physical clearance of a Z Zone would rarely start before H+48 hours although planning might be instituted at an earlier time. The wartime emergency dose of 75r will apply to all engaged. The object will be to clear the Zone as quickly as possible within the limits set by this dose and the size of the forces available.

6 Clearance by night or when visibility is bad, is likely to increase the time of exposure and should be avoided if possible. Delays caused by suspending clearance during the hours of darkness would make little difference to the total dose received by those in their fallout rooms in the Z Zone.

7 For clearance from outside, passenger carrying vehicles with a capacity of not less than 30 should be used. The use of vehicles of lesser capacity would be radiologically extravagant to clearance personnel, and should not be used unless there is no practical alternative.

8 Zones will be cleared inwards sector by sector or district by district. Throughout each sector or county district* council areas in turn self-clearance will be effected first and clearance organised from the outside will then be undertaken as far as possible simultaneously in every warden post and patrol area.

9 Clearance vehicles will operate in convoys of about five. In general one convoy will be allotted to each patrol area. To avoid unnecessary exposure to radiation of their occupants, vehicles should be sent individually to assembly towns as soon as they are loaded unless there is some good reason for acting otherwise. After unloading they will be reformed into convoys at the clearance base.

10 In built-up areas convoys will on their initial trip be directed to the warden posts and from there to the patrol areas they are to clear. In rural areas this method of routing would be radiologically expensive and should be unnecessary. Where the position of a patrol post can be easily indicated on a 1″ map the rule will be for the convoy to go direct to the patrol post in rural areas.

Allotment of responsibilities

11 Overall responsibility for deciding when a Z Zone is to be cleared and where the population of the Zone is to be moved will rest with the Regional Seat of Government which will allot responsibilities to individual Sub-regional headquarters. Responsibility for clearing segments of a Z Zone, and the transport for that purpose will be alloted by Sub-regional headquarters to county or county borough controls. Responsibility for receiving the people cleared will be apportioned to the county or county borough controls within whose boundaries the assembly towns lie. Where responsibilities are separated co-ordination will be maintained by the next higher control, e.g. co-ordination between county or county borough controls by Sub-regional headquarters.

12 A single Z Zone may well extend into two or more Regions and a single Region contain parts of two or more separate Zones. Each Zone will have been given a code name. For clearance purposes segments will be known as Regional, Sub-regional, county, and in some cases county sub, or county borough segments as the case may be, and will be further identified by the appropriate numbers and letters of the responsible control, e.g. county segment (or simply segment) 62A.

---

* NOTE: All later references to 'district' refer to 'county district council areas'.

13 Operations will be conducted by clearance units, set up by the responsible control, which will appoint the commanders, establish the bases and give each unit a segment, to be known as a clearance segment, to deal with. The boundaries of clearance segments should so far as is possible follow those of warden sectors or districts if sectors do not exist. Clearance unit comanders will normally be civil defence assistant controllers (Ops) or mobile controllers, unless the unit is provided by the military or by a police mobile column. Within a county or county borough all units, under whatever command, will be lettered in sequence and the same lettering will be used to identify the clearance segments, e.g. (clearance) segment 62AA.

14 A clearance unit should have about 125 buses or coaches, with an average lifting capacity of, say, 5,000 people. One hundred and fifty vehicles (average lifting capacity 6,000) should be regarded as the maximum. The number of lifts that can be accomplished in a day will depend on the time of year, whether the population of the segment is concentrated or scattered, and the length of run to the assembly town or staging point; but it may be expected to vary from about two to four. County or county borough control must judge from these factors the number of units required and the size of the clearance segments to be allotted to each. During the progress of operations there may well be need to adjust either the boundaries of the segments or the strength of the units.

15 It may be necessary for a clearance unit to call in the ambulance resources of counties or county boroughs in order to clear people whose physical condition makes it impossible to transport them by bus or coach. For radiological reasons the use of ambulances must be kept to an absolute minimum. If there should be an acute hospital, containing a large number of patients, in the Z Zone, special arrangements for their clearance and reception would have to be made at county or county borough level or above.

The clearance unit

16 In order that a clearance unit, when clearing each sector or district in its turn, should be able to work simultaneously in every warden post and patrol area within that sector or district it should have an operational staff approximating to the following "standard".

Clearance unit commander (1): to be responsible for organising the clearance of the sector or district generally.

Clearance officers (5): each responsible for organising the clearance of a warden post area and taking charge of a section of five convoys.

Convoy commanders (25): each in charge of a convoy of five buses or coaches operating in a given patrol area.

Drivers and mates will be needed for the 125 buses and/or coaches and drivers for the six cars with which the unit will be provided. Relief bus drivers should be sought as required, if necessary with the help of local Ministry of Labour representatives.

Signal staff and equipment for maintaining communications with the static control, should telephones not be working, and office staff for a mobile control plus six messengers, would also be required.

17 Of the above, the convoy commanders, bus drivers and mates whose duties will take them constantly in and out of the Z Zone, will have to be replaced as and when their wartime emergency doses are expended—perhaps after seven or eight lifts over two or four days. Clearance officers and car drivers and messengers will also enter the Z Zone, but less frequently and for shorter periods; so that in their case replacement should not be necessary for a long time, if at all.
(For administrative staff at base see paragraph 22).

18 This "standard" unit may be varied as required by increasing or reducing the number of buses or coaches and so the size or number of convoys or convoy sections with consequent alterations in the number of convoy commanders or clearance officers. Considerations of administration and maintenance will, however, require an upper limit of 150 vehicles.

19 Whatever unit is employed there will almost certainly be need to make constant readjustment between the various parts during the course of operations; according, for instance, to the number of warden post and patrol areas within whichever sector is being cleared, their populations, and the particular difficulties they present.

20 The designations used in paragraph 13 are entirely functional. Except where a clearance unit is provided by a military formation or a police mobile column its operational staff may be drawn from a variety of sources. (See Appendix III.) It is of great importance that the right people should be found to act as convoy commanders, since these will have the major responsibility for dealing with the public in the Z Zone, and (as will be evident from paragraph 32) the task is one requiring an ability to inspire confidence and the highest qualities of firmness and tact. The work might be undertaken by post or deputy post wardens from areas unaffected by fallout; but it is one for which police officers would be particularly well suited.

The clearance base

21 The essential facilities required for a clearance base are:

(a) Good communications.

(b) Access to adequate P.O.L. supplies.

(c) Hardstanding for the vehicles.

(d) Accommodation for personnel.

(e) Feeding facilities (these might be provided in billets or by Welfare Section emergency feeding teams).

It should be possible for the facilities to be found on the outskirts of most towns. A large bus depot would be ideal.

HOME OFFICE

CIVIL DEFENCE

TRAINING MEMORANDUM No. 6

The Evacuation of Casualties

(*PROVISIONAL*)

LONDON

HER MAJESTY'S STATIONERY OFFICE

1961

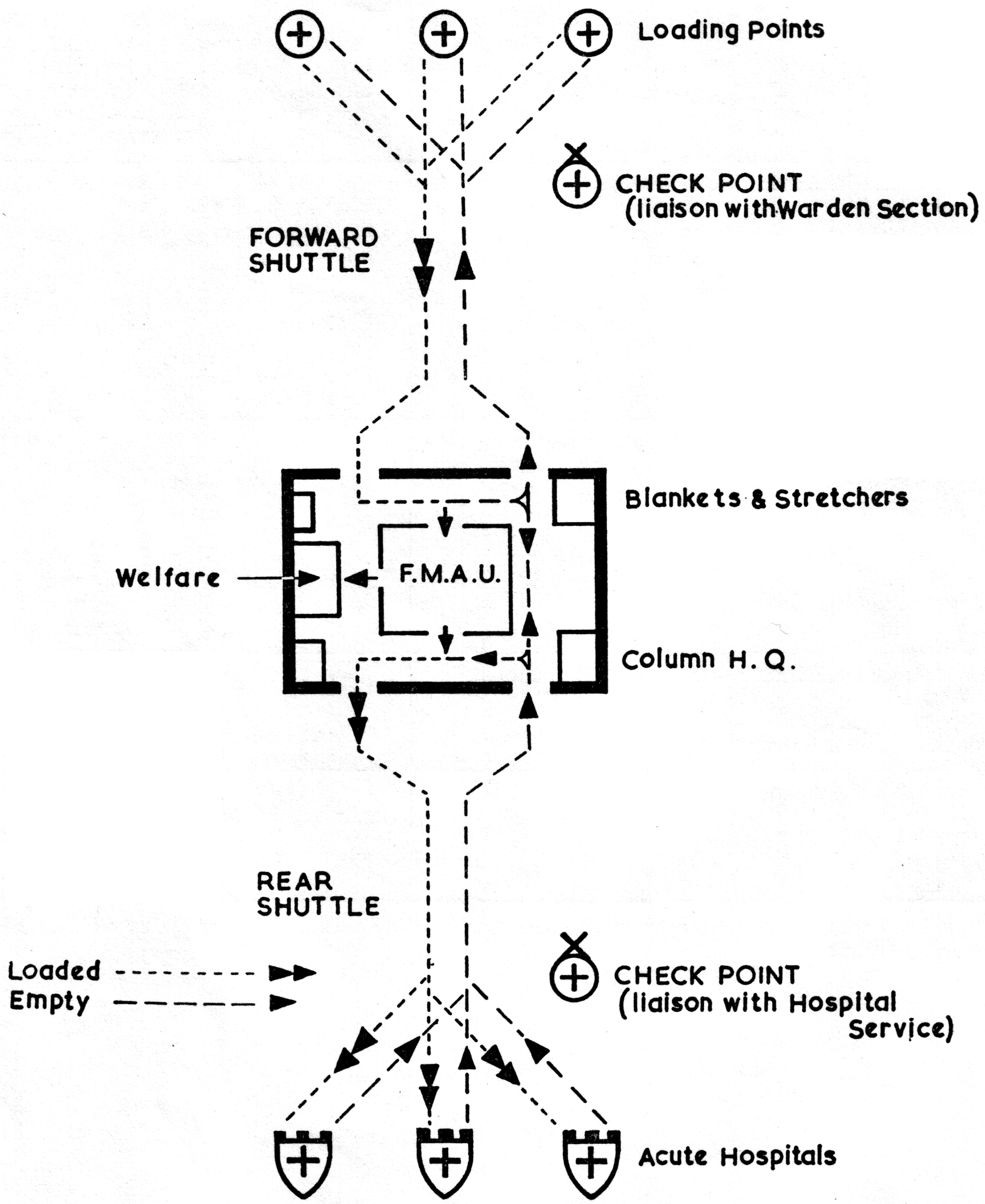
EIGHTPENCE NET

THE ORGANISATION OF AN AMBULANCE COLUMN

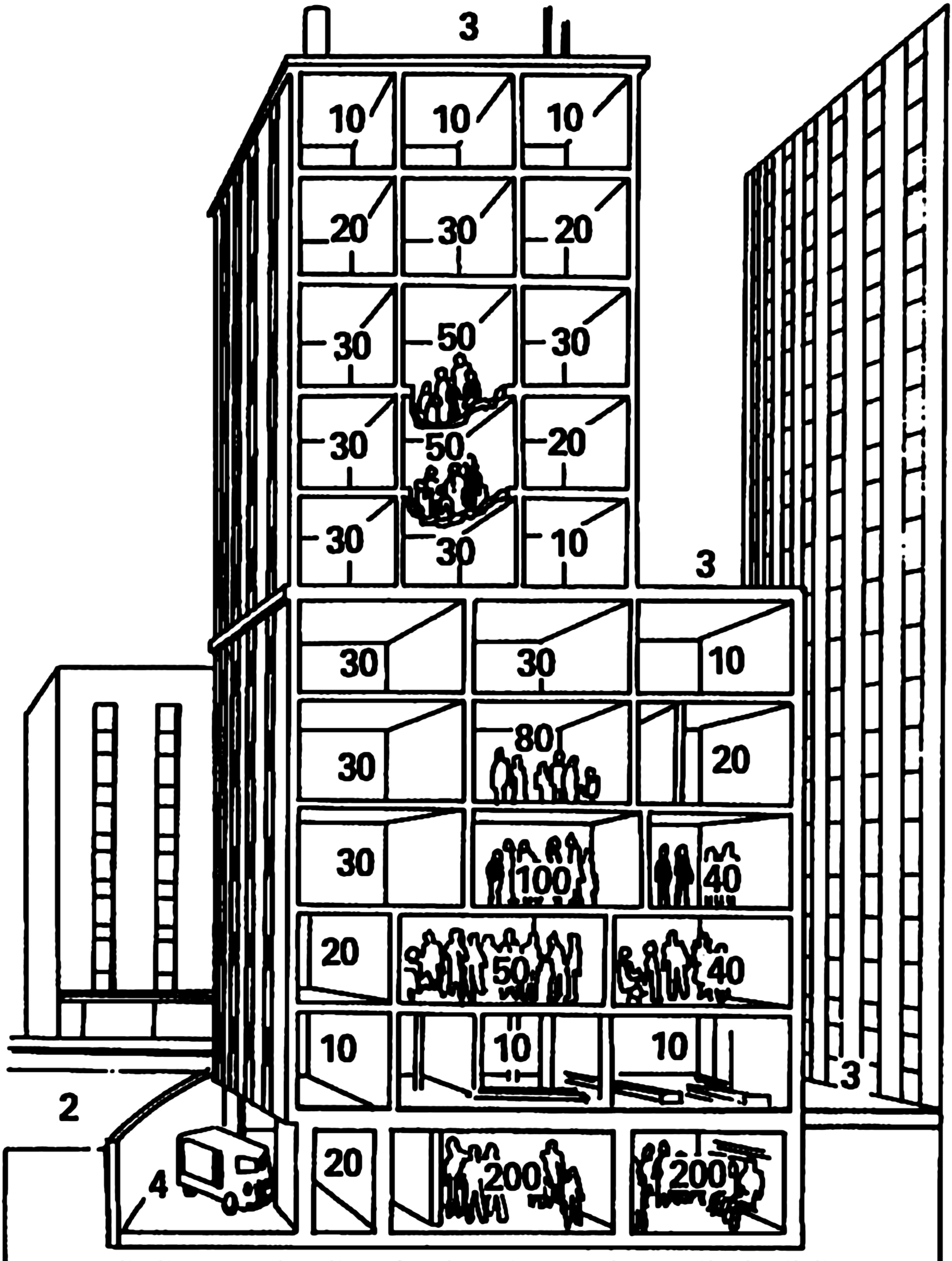
Appointment	*In charge of*	*Composition*	
		Personnel	*Vehicles*
Column Ambulance Officer Deputy Column Ambulance Officer	Ambulance Column comprising one Ambulance Company and one First Aid Company	334 (including drivers for staff cars and D.Rs.)	72 Ambulances 18 Personnel and Equipment Vehicles 10 Staff cars 10 Motor cycles
Company Ambulance Officer Deputy Company Ambulance Officer	Ambulance Company comprising four Ambulance platoons	187 (including drivers for staff cars and D.Rs.)	72 Ambulances 5 Staff cars 4 Motor cycles
Company First Aid Officer Deputy Company First Aid Officer	First Aid Company comprising three First Aid platoons	141 (including drivers for staff cars and D.Rs.)	18 Personnel and Equipment Vehicles 4 Staff cars 3 Motor cycles
Platoon Ambulance Officer Deputy Platoon Ambulance Officer	Ambulance platoon comprising three Ambulance detachments	45 (including driver for staff car)	18 Ambulances 1 Staff car
Platoon First Aid Officer Deputy Platoon First Aid Officer	First Aid platoon comprising six First Aid Parties	45 (including driver for staff car)	6 Personnel and Equipment Vehicles 1 Staff car
Ambulance Detachment Leader Deputy Ambulance Detachment Leader	Ambulance detachment	14	6 Ambulances
First Aid Party Leader Deputy First Aid Party Leader	First Aid party	7 (including driver)	1 Personnel and Equipment Vehicle

Note: Personnel and Equipment Vehicles (PEVs) Staff cars and motor cycles will not be issued for training purposes.

THE MOVEMENT OF AMBULANCES



F.M.A.U. = FORWARD MEDICAL AID UNIT (TRAINED TO APPLY PLASTER OF PARIS TO BROKEN LIMBS, ETC.)



Radiation protection factors in modern city buildings
DCPA Attack Environment Manual, ch. 6, panel 18

SANDIA REPORT

SAND2009-3299
Unlimited Release
Printed May 2009

Analysis of Sheltering and Evacuation Strategies for an Urban Nuclear Detonation Scenario

Larry D. Brandt, Ann S. Yoshimura

Executive Summary

A nuclear detonation in an urban area can result in large downwind areas contaminated with radioactive fallout deposition. Early efforts by local responders must define the nature and extent of these areas, and advise the affected population on strategies that will minimize their exposure to radiation. These strategies will involve some combination of sheltering and evacuation actions. Options for shelter-evacuate plans have been analyzed for a 10 kt scenario in Los Angeles.

Results from the analyses documented in this report point to the following conclusions:

- When high quality shelter (protection factor ~10 or greater) is available, shelter-in-place for at least 24 hours is generally preferred over evacuation.
- Early shelter-in-place followed by informed evacuation (where the best evacuation route is employed) can dramatically reduce harmful radiation exposure in cases where high quality shelter is not immediately available.
- Evacuation is of life-saving benefit primarily in those hazardous fallout regions where shelter quality is low and external fallout dose rates are high. These conditions may apply to only small regions within the affected urban region.
- External transit from a low quality shelter to a much higher quality shelter can significantly reduce radiation dose received if the move is done soon after the detonation and if the transit times are short.

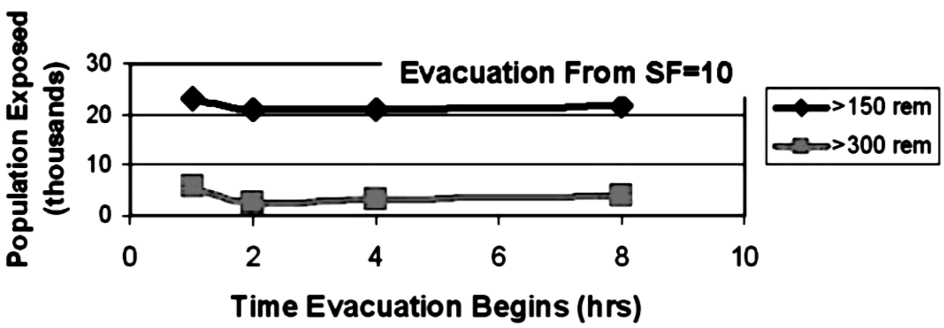
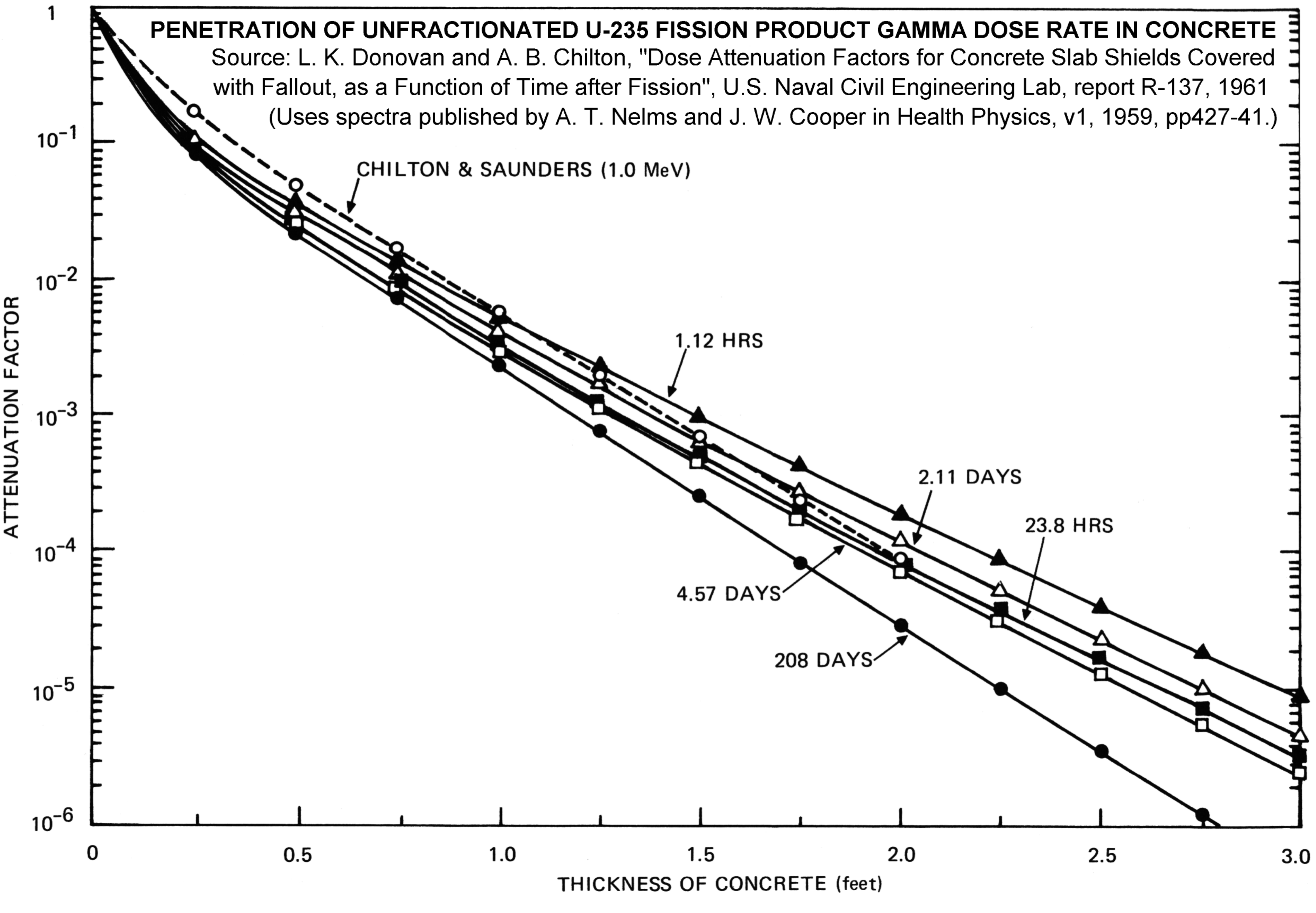


Figure 12. Departure time sensitivities for informed evacuations from shelters with SF=4

Sandia National Laboratories


PENETRATION OF UNFRACTIONATED U-235 FISSION PRODUCT GAMMA DOSE RATE IN CONCRETE
Source: L. K. Donovan and A. B. Chilton, "Dose Attenuation Factors for Concrete Slab Shields Covered with Fallout, as a Function of Time after Fission", U.S. Naval Civil Engineering Lab, report R-137, 1961
(Uses spectra published by A. T. Nelms and J. W. Cooper in Health Physics, v1, 1959, pp427-41.)
CHILTON & SAUNDERS (1.0 MeV)
1.12 HRS
2.11 DAYS
23.8 HRS
4.57 DAYS
208 DAYS
ATTENUATION FACTOR
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
THICKNESS OF CONCRETE (feet)
0
0.5
1.0
1.5
2.0
2.5
3.0

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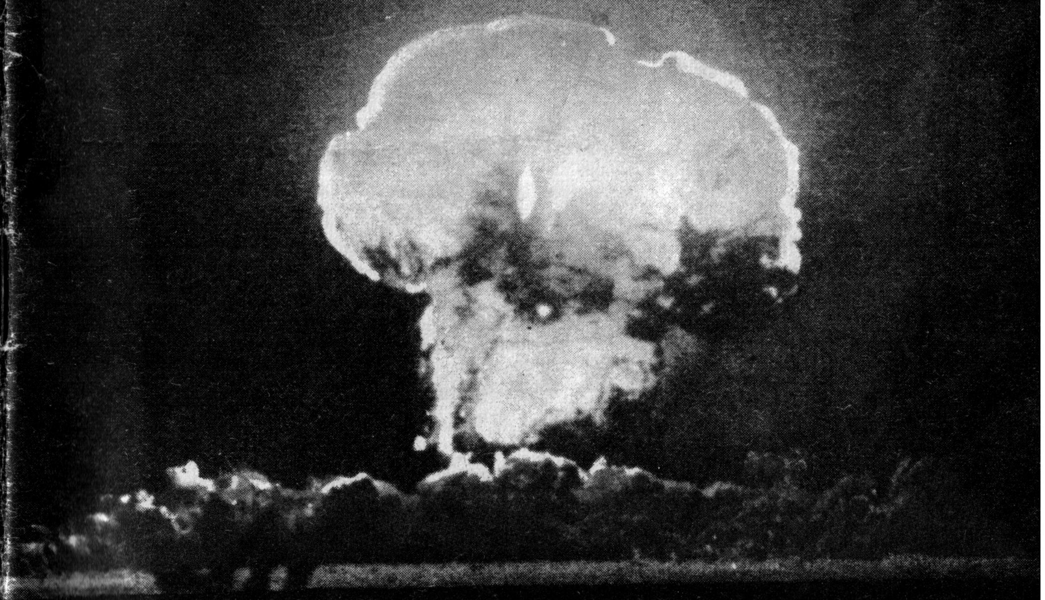
The Hydrogen Bomb



HER MAJESTY'S STATIONERY OFFICE

NINEPENCE NET

"The hydrogen bomb has made an outstanding incursion into the structure of our lives and thoughts"

SIR WINSTON CHURCHILL

In 1956 a comprehensive pamphlet on nuclear weapons and their effects was prepared by the Home Office and Scottish Home Department and published by Her Majesty's Stationery Office. Not everyone has the time to read a full technical account of this kind, which is in any case intended chiefly for use in training the civil defence services. There has been a considerable demand for something shorter and this booklet has been prepared to meet that need.

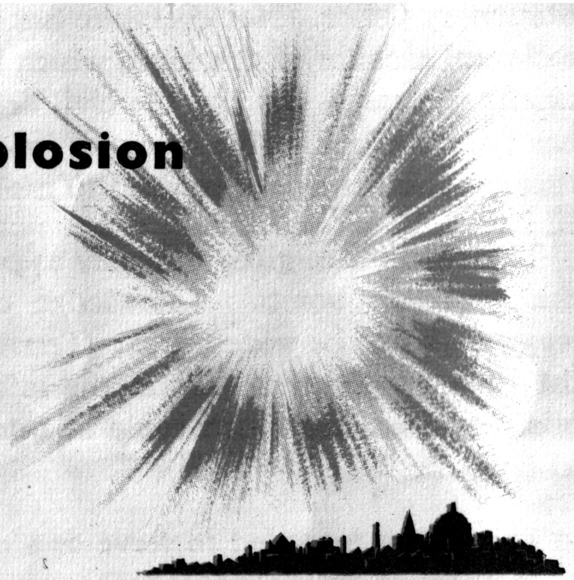
The object is to give, as briefly as possible, the facts about the hydrogen bomb. Knowledge of the effects of this weapon should be widespread. Terrible as these effects are, they can be exaggerated, and the information given in this booklet shows that much could be done to reduce them and to save lives.

This is not intended to serve as a comprehensive manual of instruction to the householder about the steps he could take to help himself and his family should war come: a much fuller booklet is being prepared for this purpose for issue should the need arise; but reference is made to some of the precautions that could be taken.

The publication of this summary does not mean that the Government think war likely. As the 1957 White Paper on Defence made clear, the existence of nuclear weapons and of the means to use them is a safeguard against aggression and a deterrent to war. But everyone should know what these weapons could do, and have some idea of how their effects could be reduced.

If more information is required, reference should be made to "Civil Defence Pamphlet No. 1 on Nuclear Weapons, published by Her Majesty's Stationery Office at 2s. 6d.

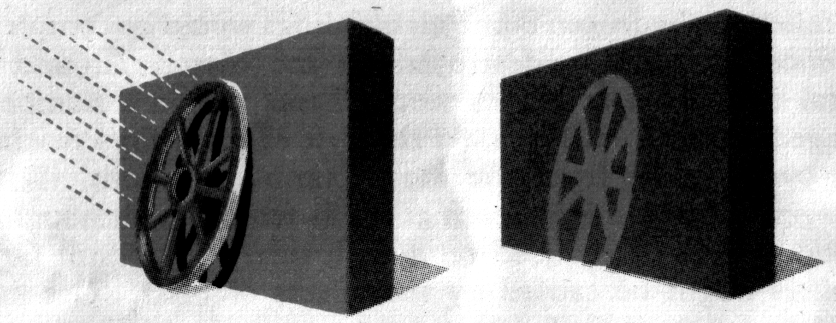
What a Nuclear Explosion is like . . .



A NUCLEAR BOMB is a device whose explosion results from the sudden release of the vast amount of energy locked up in the core of the atom. This energy is equivalent to the explosion of thousands or even millions of tons of high explosive.

The term " nuclear " includes both atomic and hydrogen bombs. These bombs vary in power just as high explosive bombs do. The atomic bomb dropped on Nagasaki, in Japan, at the end of the last war had a power of twenty thousand tons (or twenty kilotons) of high explosive. In a future war hydrogen bombs with a power of ten million tons (or ten megatons) of high explosive or more might be used. For the purposes of this booklet a ten-million-ton bomb has been assumed. We shall see that such an increase in the size of these terrible weapons does not bring a corresponding increase in their destructive power.

Anything that keeps off the sun's heat will help to give protection against the heat of a nuclear bomb. At Hiroshima, for instance, a painted surface was scorched except where it was in the shadow of a wheel.



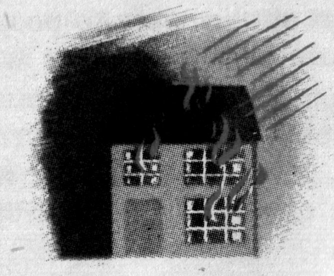
The protection given by clothing depends on the distance from the explosion. The chances of escaping serious burns are increased by wearing hat and gloves and slacks or trousers. At Hiroshima some Japanese women, who had on white cotton dresses with a darker pattern, suffered burns only beneath the pattern. The skin under the white material escaped. This was because white or light-coloured material reflects heat while dark material absorbs it. Colour apart, woollen clothes would be less likely to catch fire than cotton. If clothing did catch fire and there was no time to throw it off, the best way to put out the flames would be to roll over and over on the ground.

All this applies only to people caught in the path of the heat rays. Any solid substance would give full protection against this danger, and a few minutes' warning of the attack would give people time to take cover. Even if they had not heard a warning, people at a distance who took cover even a few seconds after the explosion of a hydrogen bomb would escape some of the heat.

THE DANGER TO BUILDINGS AND THEIR CONTENTS

Any inflammable material exposed to the heat radiated from the fireball may be ignited. Thus lace curtains in windows greatly increase the fire risk as they in their turn might set light to the contents of a room and in the end might cause a general fire in the building. It must be recognised that within three or four miles of a hydrogen bomb all buildings would be completely, or almost completely, destroyed by the blast. Around this central devastated area fires would break out in a number of damaged houses. At Nagasaki the belt of main fires reached a little over a mile from the atom bomb explosion. With a hydrogen bomb it might reach as far as ten miles, although this distance would be reduced on a dull, misty day. Still farther out, fires might be caused by the effects of blast. Gas mains would be burst, electric wires short-circuited and the contents of domestic fires scattered. Such fires might be expected anywhere up to twenty miles from the explosion.

Window panes should be whitewashed and anything inflammable removed from doorways and windows



Otherwise the heat flash will have its best chance to start fires

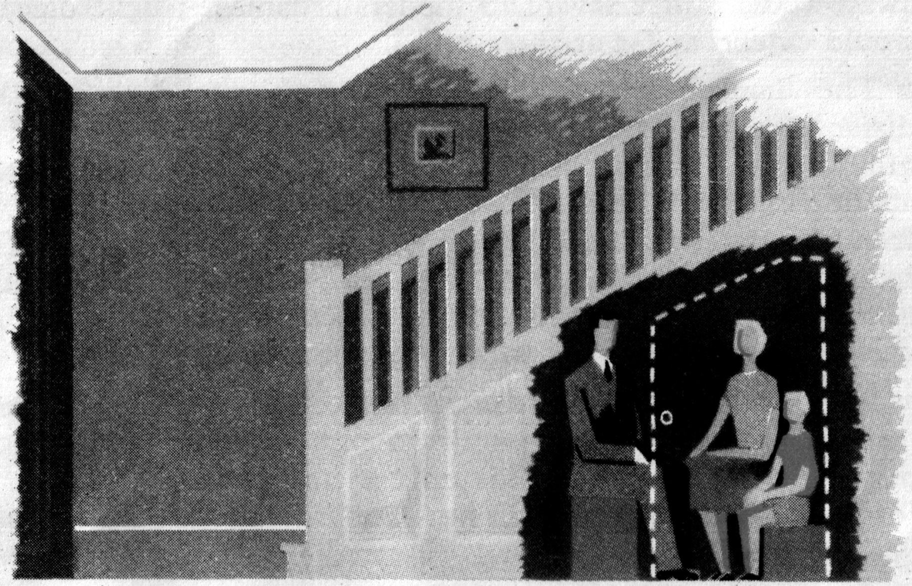
PRECAUTIONS IN BUILDINGS

Simple precautions can be taken against heat radiation, remembering that brick or stone will not catch fire, but the contents of a house might. The aim would be to prevent as much heat as possible from entering at all. One simple way would be to whitewash the windows. This would block some eighty per cent of the rays and, as they travel at the speed of light, most of the heat would be over and gone before the whitewashed windows could be broken by the slower-moving blast. Also, anything inflammable could be removed from windows and doorways. In built-up areas, the lower storeys would probably be shielded by other buildings. Here a householder would need to pay particular attention to the upper floors with a full view of the sky, and clear the rooms accordingly. If the heat were kept from causing fires by these simple precautions, one of the major hazards would be greatly reduced.

Equally simple measures could be taken to prevent fires caused by blast. Stoves could be shut down, coal and electric fires extinguished, and gas shut off at the main.

Many of the fires caused by a hydrogen bomb could be put out by the methods familiar in the last war : by beating or with a stirrup pump, or with a bucket of sand or water. If his house was not too badly damaged, a householder's first job after an explosion would be to look for such small fires and put them out. Speed would be all-important. Only when they had looked round and dealt with any fires would people take shelter from possible approaching fall-out.

*   *



The stairs would give some protection against falling debris

Best at resisting pressure are heavily framed steel and reinforced concrete buildings or those with rounded streamlined surfaces. In Nagasaki, for instance, most of the tall factory chimneys survived.

THE DANGER TO PEOPLE

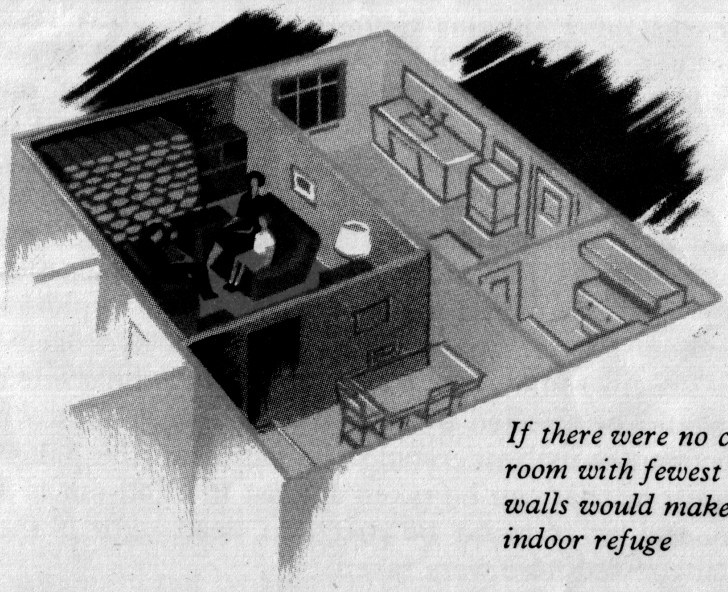
At Hiroshima and Nagasaki very few injuries, such as perforated ear-drums, were caused directly by the blast itself. The real danger is that people would be struck by falling masonry, flying debris or fragments of glass, or might themselves be thrown against some object.

The warning system, however, is designed to enable people to get under cover. A slit trench, especially if covered with a few feet of earth, or a cellar or basement would give good protection. If there were no cellar or basement it would be safest under the stairs, or under a table or bed which would give some protection should the roof or ceiling collapse; and if there were no time to reach such places before the flash is seen, the best place indoors would be close to an inside wall, avoiding windows or anywhere in the possible path of flying glass.

People caught unprotected in the open could at least try to shelter from the rubble and flying debris, if only in doorways or behind walls or even trees. Failing this, they could fall flat on the ground, with the head and face covered, if possible close to the wall of a substantial building, or in a nearby ditch or gutter.

A slit trench with earth covering protects against blast and radiation

A prepared refuge room inside a house could be made to give good protection against fall-out (although not so good as a covered slit trench) and it would also be much less uncomfortable for a period of two days or more. A cellar or basement would be by far the best place for a refuge room ; next best would be the room with the fewest outside walls and the smallest windows. The windows would need to be blocked with solid material, to the thickness of the surrounding walls at least. It would help if the walls themselves were thickened, not necessarily to their full height, with sandbags, boxes filled with earth, or heavy furniture. The occupants of the refuge room would have to remain in it until told that it was safe to come out—perhaps for a period of days—and the room would have to be prepared and equipped accordingly.



If there were no cellar, the room with fewest outside walls would make the best indoor refuge

In some places it might be practicable to make good use of both an outdoor slit trench and an indoor refuge room, using the first for protection against blast, and the second, if the house survived the blast, for subsequent protection against fall-out.

THE ARMED FORCES

Besides the civilian services there would be another important source of help : the Armed Forces. First there would be the Mobile Defence Corps which is organised into fully mobile battalions and especially trained and equipped in rescue and ambulance duties. But all the Armed Forces in the United Kingdom who were not required actively to engage the enemy would have the responsibility of assisting civil defence. Because of the planning and training now in progress they would be able to undertake a wide variety of tasks.

THE NEED FOR CIVIL DEFENCE VOLUNTEERS

The numbers available in the fighting services would, nevertheless, be so small compared with the size of the task that their availability to help in no way lessens the need for civilian forces. The local volunteer would be first in the stricken area and his local knowledge would be needed by any reinforcements coming from farther afield.

CONCLUSION

It is certain that if a nuclear attack were to come, the aid of every man and woman would be needed—service men and civilians alike. Everyone would have to help himself and his neighbour as far as he could. But improvisation would not be enough. The survival of individuals and of groups would depend on plans made beforehand ; adequate help for the victims of attack could come only from people trained and organised in advance.

The picture this booklet has painted of a nuclear attack is grim indeed ; but it is not hopeless. Much could be done. An efficient Civil Defence organisation, linked with a public that knows the facts, could save millions of lives. The best defence against chaos and confusion would be a resolute spirit of self-reliance, based not on groundless optimism, but on knowledge of the facts. That knowledge is none the less valuable because, as all hope, it may never be used.

★ ★

MANUAL OF CIVIL DEFENCE: Vol. I

PAMPHLET No. 1

Nuclear Weapons

CIVIL CD DEFENCE

2nd edition, 1959

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AND SCOTTISH HOME DEPARTMENT BY
HER MAJESTY'S STATIONERY OFFICE

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Fire protection and precautions

5.13 *Primary fires* would result from heat flash through windows, open doors, etc., igniting the combustible contents in houses, offices and stores. An obvious fire precaution would be to rearrange the furnishings or equipment and to remove all inflammable material out of the direct path of any heat rays that might enter through windows or other openings. Another very important precaution would be to whitewash windows and skylights as this would keep out about 80 per cent. of the heat radiation. The windows might be broken by the blast wave but as this travels more slowly it would arrive after the heat flash had passed (except of course in the central area of complete destruction where it would not matter).

5.14 The above precautions apply to windows and other openings with a direct view of some part of the sky. In a built-up area they would apply more particularly to the windows of upper floors: even from a high air burst the buildings would have a considerable shielding effect on one another.

5.15 *Secondary fires* might be the consequences of blast damage, scattering of domestic fires, rupture of gas pipes or short-circuiting of electrical wiring. These risks could be reduced if commonsense precautions were taken on receipt of a warning, such as shutting up stoves, covering open fires with sand or earth and by turning off gas and electricity at the mains.

The possibilities of a fire storm

5.16 The chief feature of a fire storm is the generation of high winds which are drawn into the centre of the fire area to feed the flames. These in-rushing winds prevent the spread of the fires outwards but ensure almost complete destruction by fire of everything within the affected area. A fire storm inevitably increases the number of casualties since it becomes impossible for people to escape by their own efforts and they succumb to the effects of suffocation and heat stroke.

5.17 The 20 KT Hiroshima bomb (but not the Nagasaki one) caused a fire storm and fire storms were caused in Hamburg* and in several other cities as a result of heavy incendiary attacks in the last war. A close study of these fire storms and of German cities in which fire storms did not occur revealed several interesting features. A fire storm occurred only in an area of substantial size (i.e. several square miles) heavily built-up with buildings containing plenty of combustible material and where at least every other building in the area had been set alight by incendiary attack.

5.18 It seems unlikely that an initial density of fires equivalent to one in every other building would be started by a nuclear explosion over a British city; studies have shown that a much smaller proportion of buildings than this would be exposed to heat flash (due to shielding). Moreover, the vulnerable centres of many British cities were destroyed in the last war and the new buildings which are replacing them are mainly of fire-resistant construction and less closely spaced. Fire storms after nuclear attack are therefore unlikely in most British cities but the risk would be greatly reduced by adopting the precautions outlined above.

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* About 1,625,000 escaped injury during the fire storm at Hamburg, although out of a population of about 1,700,000 at risk, the 35-40,000 killed represented about 10% of the whole of civilian deaths in Germany from air attack throughout the war.

CHAPTER XI

Summary of Methods of Protection and Decontamination for the Individual

Protective preparations to be taken in an emergency

11.1 All windows and skylights that have a direct view of some part of the sky should be whitewashed. The whitewash would reflect much of the heat of the fireball and so help to stop the heat rays from getting inside the building and setting fire to inflammable objects.

11.2 Attics and lofts should be cleared of all inflammable materials. In other parts of the building, anything inflammable should be removed from the vicinity of windows and other openings, e.g. piles of newspapers on a window-seat or a table near a window.

11.3 Curtains should be removed from windows or made flameproof by soaking in a fire-retardant solution*.

11.4 Baths should be kept full of water and buckets of water should be placed in all rooms for the quick extinction of fires, glowing wood, fabrics, etc.

11.5 The family refuge should be prepared. This should be in the basement or cellar if there is one; otherwise, an innermost room on the ground floor, farthest from external walls and protected by the maximum total thickness of walls on all sides, should be chosen. If a last-war garden shelter is available, the earth-cover should be thickened to about 3 ft.

11.6 The windows of the refuge room should be blocked up or shielded so that they give protection as good as that from the rest of the walls of the refuge, e.g. by erecting a "wall" of sandbags or of boxes filled with earth or sand built up outside the room up to a height of 6 ft. above floor level (or to the top of the window if it is overlooked by trees or by higher ground within 100 ft.).

11.7 Stocks of first aid materials and adequate food supplies for about one week should be collected in or near the refuge: food should be in tins or in waterproof containers or, where appropriate, wrapped in greaseproof paper and put into tins to protect it from plaster, glass and other debris if the house is damaged.

11.8 A supply of drinking water should be stored in jars or bottles, preferably sealed, but at least covered to keep out dust.

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* Suitable solutions for household use are 3 lb. boric acid plus 2 lb. sodium phosphate (or, alternatively, 3 lb. borax plus 2 lb. boric acid) dissolved in 3½ gallons of water. Curtains and fabrics should be thoroughly soaked in the solution and the excess liquid squeezed out before they are rinsed and dried.

11.9 Should there be no indoor W.C., sanitary facilities for use during occupancy of the refuge should be provided.

11.10 In large buildings, natural ventilation should be considered in choosing refuge rooms particularly in a basement. While electrical power remains available, fans should be used either to expel the air from the refuge room through an external vent or to draw fresh air from other spaces within the building. If the building has a forced ventilation system, downward-facing air inlet pipes should be fitted externally and the ends covered with a fine wire gauze screen. If the electrical power fails, sufficient natural ventilation can be achieved if the selected refuge room has an ordinary fireplace and chimney or if it has a ventilation grid near the ceiling opening to the external air, or to some other large space within the building and if, at the same time, the door of the refuge room and all other internal doors on that floor are kept open.

If neither of these conditions is fulfilled, holes could be made near the ceiling in one of the internal walls of each refuge room, opening into larger spaces within the building.

11.11 Bunks or mattresses should be provided as liberally as possible in each refuge room: a person needs nearly twice as much oxygen and exhales twice as much carbon dioxide when sitting as when sleeping and still more when standing and walking about.

Protective measures during and after a nuclear attack

People caught in the open

11.12 No one should be out of doors after a warning of attack had been given except those whose duty required them to do so. Such people would have a specific refuge in mind or at least would know at any moment how to obtain the best protection against the various effects of nuclear weapons.

11.13 If you were out in the open and you saw the flash of the explosion of a nuclear weapon, you might be temporarily blinded but you should try immediately to get behind the best nearby cover that was available, so as to obtain protection from the heat rays and from the effects of the subsequent blast wave and flying debris. Cover on all sides as well as overhead would, of course, be the best: failing that, you should get behind a wall or other solid structure. If there was no other cover, you should lie face down on the ground (in a ditch, gutter or other depression, if possible) using your arms, or a coat or jacket, to cover the head and any exposed skin.

11.14 After the blast wave had passed there would be ample time before the start of fall-out (about half an hour in the case of a large bomb) to enable you to get into a prepared refuge against the fall-out.

People in refuges

11.15 After the blast wave had passed a quick inspection should be made of all rooms in the house or building, including spaces under the roof. Fires which had started and all glowing wood or other material should be extinguished.

11.16 Urgent repairs or weatherproofing which could be completed within half an hour should be done. Curtains or sheets should be tacked over broken windows to keep gross amounts of fall-out from being blown into the rooms. There would be no cause to worry about small amounts of fall-out getting into damaged parts of the house—provided it was not allowed to get into food or water consumed in the refuge room. If dust was visible later in any room it should be swept and dumped outside.

11.17 Except possibly in the area damaged by a nuclear explosion, two separate fall-out warnings* would be given, the *first* to indicate that fall-out was likely, i.e. might arrive at any time after 1 hour and the *second* when it was imminent. After the blast wave had passed and until the imminent warning was received all necessary help and first aid should be given to neighbours.

Protective measures after fall-out had ceased

11.18 You should remain in the refuge for the first 2 days after the explosion or until you had been told that your district was free from radioactive fall-out. If you did not receive any instructions you should stay in your refuge as long as possible (i.e. you should not remain any longer than was necessary in other parts of your house). Above all, you should not go out of doors until you received further instructions. If you were well inside the fall-out area it might not be possible to get further information or instructions to you until the third or even fourth day after the explosion.

11.19 These instructions would tell you how many hours you might safely spend each day out of your refuge (*a*) in other parts of your house (where the shielding is less) and (*b*) outdoors getting food rations and other needs for your family. They would also tell you WHERE and WHEN to go for these food, water and medical supplies so that you would not have to wait and be exposed unnecessarily to a high dose-rate. When you had to go outside for this purpose you should use, if possible, quick means of transport (bicycle or car) so that you could reduce your exposure outdoors to the absolute minimum.

11.20 The advice given to you would depend on the type of house you lived in and amount of shielding it afforded against gamma radiation. The advice would be designed to let you have as much freedom as possible without incurring radiation sickness. It would be essential that you and all members of your family should follow the advice strictly.

11.21 If you did not receive instructions before the end of the third day, it might be because you were in an area of high dose-rate. If so, it would be all the more necessary for you and your family to remain in your refuge room, to spend as little time as possible in other parts of the house and to avoid outdoor exposure until you had been told what you might safely do. 10 R/hr > at 48 hours

11.22 If the dose-rate in your area was above a certain intensity you would be given advance notice of arrangements to clear people from the area street by street or maybe house by house. You would be told exactly WHEN and WHERE you would be collected. You would

* See paragraphs 3.4, 3.5 and 8.9.

"Z Zone" FALLOUT
EVACUATION

have to be ready at the exact time and place; otherwise, you might imperil not only your own life but the lives of those who were accepting heavy risks, carefully calculated in time, in trying to rescue you and your family and neighbours.

Decontamination of skin and clothing

11.23 It has been explained in paragraphs 8.11 to 8.13 that the hazard from contamination on the skin and clothing is a relatively minor one compared with the hazard caused by the general field of gamma radiation from fall-out. If you suspected that you had been contaminated with radioactive fall-out you should use the following decontamination procedure as soon as you got to your refuge:—

(*a*) Remove all outer clothing and place it in a room or cupboard separate from your refuge room. It would be useful to have bags of polythene or similar material into which contaminated articles could be placed since the bags could be handled later with a much smaller risk of spreading the contamination. In removing the outer clothing, care should be taken *not* to shake it as this would disperse radioactive dust unnecessarily into the atmosphere.

(*b*) The hands, head and neck should then be thoroughly washed and scrubbed with soap and warm water while bending over a hand basin. This washing should be repeated at least once, taking care to brush under the nails thoroughly.

11.24 If you had been covered heavily with fall-out, you might develop skin burns on the exposed parts of the body but these would heal normally provided you had not also been exposed to excessive doses of gamma radiation.

11.25 Contaminated clothing can be cleaned to a very considerable extent (almost complete removal of fall-out particles) by either or, where appropriate, both of the following methods:—

(*a*) Removal of dust from the clothing by means of an efficient household vacuum cleaner, or

(*b*) Soaking and stirring the clothing in a solution of household detergent—either 5 minutes in a washing machine or 5 minutes vigorous stirring (with a suitable stick) in a bath or bucket—followed by thorough rinsing in clean water.

Decontamination of roads and paths

11.26 In urban districts, arrangements might have to be made to decontaminate certain roadways and hard paths around houses which had to be used soon after the two-day refuge period and residents might be asked to help. A certain amount of decontamination could be achieved after a land burst by hosing or swilling contaminated hard surfaces with water if drains are available.

1.22 For every weapon there is an optimum height of burst which will produce the greatest blast effect. In kiloton weapons, this optimum height is significantly greater than the critical height at which the fireball will just touch the ground, e.g. for a 20 KT weapon the critical height is 600 ft. and the optimum height of burst is about 1,000 ft. for damage in a typical British city. The corresponding data for a 10 MT weapon are about 1·36 miles for the critical height and about 1·5 miles for the optimum height.

-this height of burst avoids local fallout (no dust enters fireball)

"Clean" and "dirty" bombs

1.23 Fission products are released by all existing types of nuclear weapon. "Dirty" bombs produce a lot and "clean" bombs produce little, the dirtiness depending upon the ratio of fission to fusion in the bomb. The dividing line between "clean" and "dirty" bombs is thus a matter of opinion, but the fission-fusion-fission type of weapon mentioned in paragraph 1.5 would be a "dirty" one.

Possible methods of attack with nuclear weapons

1.24 Weapon design has improved so much that it is possible to incorporate megaton warheads in a variety of weapons, including ballistic missiles with a range of several thousand miles. Possible means of delivery are listed below:—

(i) Manned bombers (subsonic or supersonic).

(ii) Long-range pilotless aircraft released from land or from ships at extreme ranges. (E.G. "V1" CRUISE MISSILE.)

(iii) Long-range guided bombs released from aircraft several hundred miles from the target.

(iv) Ballistic missiles—IRBM's (Intermediate Range Ballistic Missiles) and ICBM's (Inter-Continental Ballistic Missiles)—released at extreme ranges from land, ships off-shore, or from submerged submarines.

(v) Undercover methods of attack. (TERRORISM.)

1.25 Missiles with wings can be guided over the whole range to the target but since they depend on air to feed the engine, to support the wing loading and to exert forces on control surfaces, they are limited in speed and height of operation and are therefore more vulnerable to counter attack than ballistic missiles. The latter can be guided into the correct direction and altitude to reach the target as long as the rocket motor is operating; thereafter they must follow a ballistic path like a shell from a gun. However, ballistic missiles travel for most of their range at altitudes of several hundred miles where there is practically no air resistance and they can reach maximum speeds of 15,000 miles per hour and average range speeds of several thousand miles per hour. Nothing has been disclosed about the accuracy of existing IRBM's or prototype ICBM's but with good equipment and an efficient guidance system, the error in the point of impact should not be greater than the extreme ranges of damage and fire from larger megaton weapons. Ballistic missiles have one weakness as weapons of war—their trajectory takes them above the earth's atmosphere, and the heating effect due to air friction on re-entry may cause them to heat up and become distorted. This can be avoided at the expense of additional complications in design and

reduced size of warhead, but such weapons will remain vulnerable to the intense heat effect from a defensive nuclear missile detonated in the vicinity of the attacking weapon.

1.26 The major problems in countering attacks from IRBM's and ICBM's within the time available between launching and impact are to detect the weapon, to compute its ballistic path and to fire and detonate a defensive nuclear missile at a high altitude and close enough to its path to destroy it. These problems are being studied and may be solved as a result of further advances in radar tracking equipment and high-speed electronic computing machines.

Factors affecting an attack

1.27 The damage to life and property that might be caused by nuclear detonations would depend upon:—

(i) The bomb power, which might be anything from a few kilotons, up to the megaton range.

(ii) The type of burst, e.g. air, water or ground-burst, and where it occurred.

(iii) The prevailing meteorological conditions, i.e. wind strengths and directions at all levels through which radioactive particles might fall.

(iv) The method of attack and the time available for warning the public to take cover: this might be reduced to minutes in an attack with IRBM's or ICBM's.

(v) The protective measures taken before and after the detonation.

(vi) The knowledge of the public of nuclear hazards, and their sense of discipline and readiness to respond to official advice on protective measures.

(vii) The proficiency of all services connected with civil defence in correctly advising the public, in fighting fires and carrying out other life-saving operations.

Estimation of ranges of effects from bombs of different power

1.28 In planning civil defence operations after an attack with nuclear weapons, information would be needed for each detonation on:—

(*a*) The power or yield of the weapon.

(*b*) The time and the location, i.e. ground zero (GZ) of burst.

(*c*) The height of burst.

(*d*) The wind strengths and directions at all levels up to the top of the highest radioactive cloud.

How this information would be obtained is described in Chapter III.

1.29 When the above facts were known, simple methods would be required for estimating quickly the ranges of the various effects produced by the weapon sizes used. Such estimates would be needed to assess the overall magnitude of the civil defence problems and tasks and they would include the ranges of varying degrees of structural damage, of road blockage, of fires and skin burns and of the main

TABLE 15

Downwind contamination

PAGE 42:

Areas of contours at 7 hours after burst, assuming 100 per cent. fission yield

Reference contour dose-rate r.p.h. at 7 hours after burst (DR7's)	*Areas in square miles for weapon power*						
	20 KT	*100 KT*	*½ MT*	*1 MT*	*2 MT*	*5 MT*	*10 MT*
300	0.2	1.2	27	54	108	270	540
100	1.3	6.4	105	210	420	1,050	2,100
30	5	25	325	650	1,300	3,250	6,500
10	16	82	750	1,500	3,000	7,500	15,000
3	50	250	1,650	3,300	6,600	16,500	33,500
1	200	1,000	4,250	8,500	17,000	42,500	85,000

"Z Zone" for evacuation at 48 hours (10 R/hr at 48 hrs = 100 R/hr at 7 hours, due to decay)

TABLE 18

PAGE 49:

Half value thicknesses of shielding materials against residual radiation

Material	*Slab density lb. per square foot and per inch thickness*	*Half value thickness (inches)*
Steel ..	41	0.7
Concrete ..	12	2.2
Brickwork	10	2.8
Earth ..	8	3.3

Thus a 2·2 in. thickness of concrete will reduce the dose of residual radiation to one-half of its original value, 4·4 in. will reduce it to a quarter, 6·6 in. to one-eighth and so on. Brick walls 4½, 9 and 13½ in. thick will reduce the intensity of residual radiation by factors of 3, 10 and 30 respectively. As shields are made thicker and larger the contribution from scattered radiation which penetrates increases, so that the reduction factor is slightly more for thinner shields and slightly less for thicker shields than those indicated above.

* The energy of gamma radiation is usually expressed in units of a million electron volts (Mev): the gamma ray released when a nitrogen atom captures a neutron may exceed 10 Mev: the average energy of initial gamma radiation is 4.5 Mev whereas that of residual radiation from fall-out is only about 0.7 Mev. - page 23

† These data are taken from more elaborate data in the series of curves on page 352 of the U.S. publication " The Effects of Nuclear Weapons " (see Preface) where similar curves for neutron and neutron plus gamma doses are shown on pages 366 and 372.

Survey of dwelling houses in the United Kingdom PAGE 52:

9.21 Surveys have been made of different types of dwelling houses in the United Kingdom and their protective factors have been calculated for ground floor refuge rooms in which there is no external door and the windows have been blocked. For this purpose it was assumed that the fall-out is uniformly distributed on the roof and on the ground around the building. The calculated protective factors (which are approximate) are shown in Table 21.

TABLE 21

Approximate protective factors in ground floor refuge rooms of typical British houses with timber upper floors

Types of house	*Protective factor*
Prefab	3
Bungalow	5–10
Detached two-storey	15
Semi-detached two-storey 11 in. cavity walls ..	25–30
Semi-detached two storey 13½ in. brick walls ..	40
Terraced two-storey	45
Terraced back to back	60
Tenements	*

There is some evidence that the fall-out may not all remain on sloping roofs and that consequently the protective factors of most British houses will be higher than the values given in Table 21: this applies especially to the houses with the lower protective factors where a large fraction of the radiation comes from contamination on the low roof.

Basements and trenches

9.22 A substantial increase in protection could be obtained if any of the above houses had an additional cellar or basement, or a trench under the floor: e.g. for a two-storey house the trench would give a protec-

* See paragraph 9.1. Protective factors in tenements can vary widely as they depend upon the size of the building, the massiveness of its construction and the number of storeys used as refuges. On the ground and first floors, PF's may vary from 100 to 500, on second floors the PF may be 50 and on top floors they may be in the neighbourhood of 20.

tive factor (PF) of about 200 and the basement a PF of between 140 and 340, depending on whether or not the basement was adjacent to a semi-sunk area, and if so, on the size of the latter.

9.23 A slit trench with even a light cover of wooden boards or corrugated iron and a tarpaulin will give a protective factor of 5 to 10 and with an additional 3 ft. of earth cover the protective factor will be very high (e.g. 200 to 300 or more).

10.8 The main sources of drinking water in the United Kingdom are underground wells, rivers and impounding reservoirs fed from catchment areas. Wells and reservoirs each supply slightly more than a third of the population and rivers just under a third. *Underground sources* of water would, in general, be free from contamination but if the water is stored in open reservoirs there is a possibility of contamination. *In rivers* many of the fall-out particles would sink to the bottom or be held in mud and vegetation. Some of the active material which dissolves in the river water would be absorbed by mud and vegetation and the rest would ultimately flow to the sea. It seems reasonable to expect that river water would not be contaminated above emergency levels for long periods.

10.9 The large surface areas of *impounding reservoirs* are open to fall-out and the contamination of the water to hazardous levels is therefore possible. It is worth noting in this connection that one of the normal methods of water softening in current use in some industries, known as the base or ion-exchange process, could remove nearly all the radioactive matter dissolved from fall-out.

10.10 As explained in paragraph 10.7 it is proposed to cut off water which is contaminated above the tolerance levels. It is not possible to say for how long, because this would depend upon the level of contamination and the availability of other supplies of fresh water. It would be important for householders to store as much water as possible in order to provide a reserve supply for emergency use. The utmost economy should be exercised in the use of these supplies, some of which should be kept near the emergency refuge.

Industrial cooling water

10.11 Many industrial installations have a small reservoir and recirculating system for cooling water. If possible, the exposed water surfaces should be covered to prevent entry of heavy fall-out. If fall-out did enter, much of it would sink to the bottom or become absorbed in growths on the bottom and walls of the reservoir, and if the depth of water was more than three to four feet, it would be an adequate radiation shield. Provided the water was *not* used for human consumption the soluble radioactive content would present a negligible external radiation hazard when the cooling system was in use.

Sewage disposal

10.12 The harmless disposal of sewage normally depends at some stage on the action of micro-organisms. The risk of injury to the micro-organisms by fall-out is negligible. The main hazard would be possible leakage of radio-strontium, radio-barium and radio-caesium through the sewage plant into a river used as a source of drinking water not far downstream.

10.13 In the event of widespread fall-out in built-up areas, much of the fall-out might be washed by rainfall or in decontamination operations down the gutters and into street drains. To a large extent it would be trapped there until it decayed but it would not constitute

a significant hazard to the public because of the depth of the drains underground. Collaboration of sewage, water and river authorities would be necessary to dispose of the contaminated drainage with least harm to water supplies and to sewage plant, e.g. by arrangement to by-pass it through storm overflows and to stop drawing drinking water supplies from the river during this period.

Food stocks

10.14 It is not the purpose of this pamphlet to review the administrative problems which would face the Ministry of Agriculture, Fisheries and Food after the widespread destruction and the disruption of communications and transport consequent on a nuclear attack on this country. Official reviews of these problems and of the steps being taken to deal with them have been published elsewhere*. This section will be confined, therefore, to basic advice for the protection of people and animals, and their sources of food.

10.15 Many communities isolated by heavy fall-out would have to rely on their available local stocks of food, including that in houses and retail shops, for an indefinite period until arrangements could be made for emergency feeding. It is of vital importance, therefore, that no food be wasted. The monitoring organisation will separate clean from contaminated food and unless the latter is perishable it must be retained until specialist advice has been obtained on how to salvage the maximum amount.

10.16 *Gamma radiation has no harmful effect on foodstuffs* except at dose-rates far in excess of those likely to be encountered where food survives any nuclear detonation. Neutron bombardment might induce some radioactivity but this would not occur outside the area of complete destruction and by the time such food could be salvaged it would be safe to consume. The only significant hazard to food, apart from growing crops, would be the deposition on it of radioactive fall-out which might eventually find its way into the human body. Food contained in impervious wrappings would be safe to eat provided that the wrapping had not been damaged physically. It would be safe to eat provided care was taken to remove the fall-out from the exterior of the container and to prevent contamination of the contents when the container was opened. This would apply also to food in paper wrappings provided the paper had not been soaked with wet fall-out or by subsequent rain (see paragraphs 1.19 and 10.3).

Growing crops

10.17 Heavy fall-out would, of course, preclude any possibility of lifting crops until the dose-rate had fallen sufficiently to permit limited and calculated exposure periods. Crops contaminated with fall-out would need careful handling to prevent the transfer of radioactive matter to the skin, hair or clothing and thence into the mouth or into cuts and abrasions.

10.18 Root crops should be fit for consumption after thorough washing, and so should peas and beans in the pod if the pods were washed before, and the peas after shelling. The hearts of cabbage, sprouts and lettuce should be thoroughly washed after discarding the outer

---

* See footnote to paragraph 10.2.

(REFERENCE: Dr John F. Loutit and Dr R. Scott Russell "Operation Buffalo, Part 5, The entry of fission products into food chains", Atomic Weapons Research Establishment, report AWRE-T-57/58, May 1959, 216 pages: 90% of Buffalo-2 ground burst fallout was removed from wheat by threshing it. 90% was in the chaff removed by threshing, only 10% on grain.)

leaves. Hard skin-fruits could be washed and peeled but soft fruits should be discarded. Flour produced from cereal contaminated with fall-out would contain only a small fraction of the original contamination. ⇒ 10% for Buffalo-2 nuclear test, see report AWRE-T57/58.

10.19 The effect of fall-out on crops would depend upon their state of growth at the time: if they were in the early stages of growth they would absorb radioactive matter through the root system as well as becoming contaminated on the leaves or other parts above ground. The contamination of the soil present farmers with many other long-term problems. Most of the radioactive components in fall-out would not be washed deeply into the soil but would be retained in the top few inches, and it would be generally advantageous to dig or plough the contamination deeply into the soil and to add lime where there was lime deficiency as this would reduce the uptake by plants of any traces of radioactive strontium which might be present.

"LIME" = Calcium Salts, eg $CaCO_3$

Livestock + add potassium chloride to block Cs-137

10.20 Livestock are affected by fall-out and by radiation in much the same way as human beings. They can suffer radiation sickness, skin burns from fall-out and internal injury to the gastro-intestinal tract when fall-out is swallowed in food or water. As in human beings radio-iodine accumulates in the thyroid gland and radio-strontium accumulates in the bones of animals. In general, the lethal dose depends on size, but among larger animals cattle and horses are slightly more sensitive and sheep and pigs slightly less sensitive than human beings. Except for dairy cattle and breeding stocks, the long-term effects of radiation would be of little consequence because, normally, the animals would be slaughtered long before these effects could become manifest.

10.21 The flesh of animals exposed to initial gamma flash or to residual radiation from fall-out (unless they are in the last stages of illness) would be fit for human consumption provided the bones and the offal were discarded.

10.22 Where practicable, animals should be put under cover and fed with clean food and water, priority being given to breeding stock and dairy cattle.

Milk and eggs

10.23 Cattle secrete in the milk a considerable proportion of the radio-iodine and radio-strontium they absorb. It is anticipated that over large areas of the country the milk produced by cows grazing in the open would be unsafe for infants fed entirely on milk. If facilities were available it would be possible to save contaminated milk by converting it into butter and cheese and storing these products until the radioactivity had decayed, or, in the last resort, by feeding it to animals, e.g. pigs and poultry.

5. It is not possible for a nucleus to consist of protons alone, because the repulsive forces between the positive charges would make them fly apart: in nuclei containing more than one proton this is prevented by the presence of the neutrons and by the attractive forces between the different fundamental particles in close proximity. The atoms of all the elements, with the exception of the simplest type of hydrogen atom, contain at least as many neutrons as protons and the larger the nucleus, the greater is the excess of neutrons over protons needed to hold the nucleus together.

6. All atoms of one element contain the same number of protons but they may have different numbers of neutrons. Thus, several atomic species of the same element are possible and these are called *isotopes* of that element. There is a limit to the number of possible isotopes of each element and those which contain too many or too few neutrons are unstable or radioactive and disintegrate sooner or later, by expelling neutrons or electrons (resulting from the conversion of neutrons to protons) in order to restore the balance in the ratio of neutrons to protons needed for stability. Under those circumstances the electron expelled at high speed from the nucleus is called a beta particle. A succession of changes or disintegration may occur before a stable nucleus is formed and, in many of these, excess energy may be emitted also in the form of gamma rays, an electromagnetic radiation like light or X-rays but of much shorter wavelength. A frequent occurrence, particularly among heavier radioactive atoms, is the expulsion of an alpha particle which is, in fact, the nucleus of the gaseous element helium (containing two protons and two neutrons) without its two outer electrons.

12. Published information suggests that an unconfined sphere of U-235 metal of about 6½ in. diameter and weighing about 48 kilograms would be a critical amount: this would be reduced to about 4½ in. diameter (16 kg.) for a U-235 sphere enclosed in a heavy tamper. The critical sizes for U-233 and Pu-239 have not been disclosed but are somewhat smaller than for U-235. The increasing mechanical complication of bringing together, rapidly and simultaneously, a number of sub-critical pieces of fissile material sets a practical limit to the power of nuclear fission weapons.

Nuclear fission and thermonuclear weapons

13. A temperature of several million degrees centigrade is reached in the detonation of a nuclear fission weapon. At this temperature atoms are stripped of most of their surrounding cloud of electrons and the nuclei move at very high speeds experiencing many collisions with one another. Under these circumstances the nuclei of the rarer hydrogen isotopes deuterium and tritium have enough energy of motion to overcome the repulsive forces between their single positive electrical charges and they are able to fuse together. The energy released in the fusion of these two nuclei is about one-twelfth of that released in the fission of a single U-235 nucleus, but on an equal weight basis, the fusion energy is about two and a half times as large as the energy of fission of U-235.

14. In the process of fusion a neutron is released at a very high speed from each pair of reacting nuclei and it has enough energy to split the commoner atoms of U-238. Thus, if U-238 metal is used as the bomb case in a thermonuclear weapon the quantity of fission products will be increased many times. This type of weapon is the fission-fusion-fission type or so-called "dirty" bomb.

HOME OFFICE

SCOTTISH HOME DEPARTMENT

MANUAL OF CIVIL DEFENCE

Volume I

PAMPHLET No. 1

NUCLEAR WEAPONS

LONDON

HER MAJESTY'S STATIONERY OFFICE

1956

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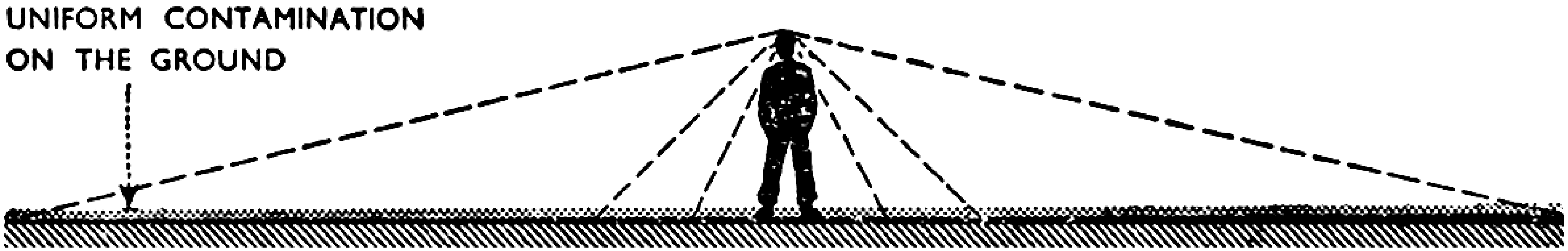
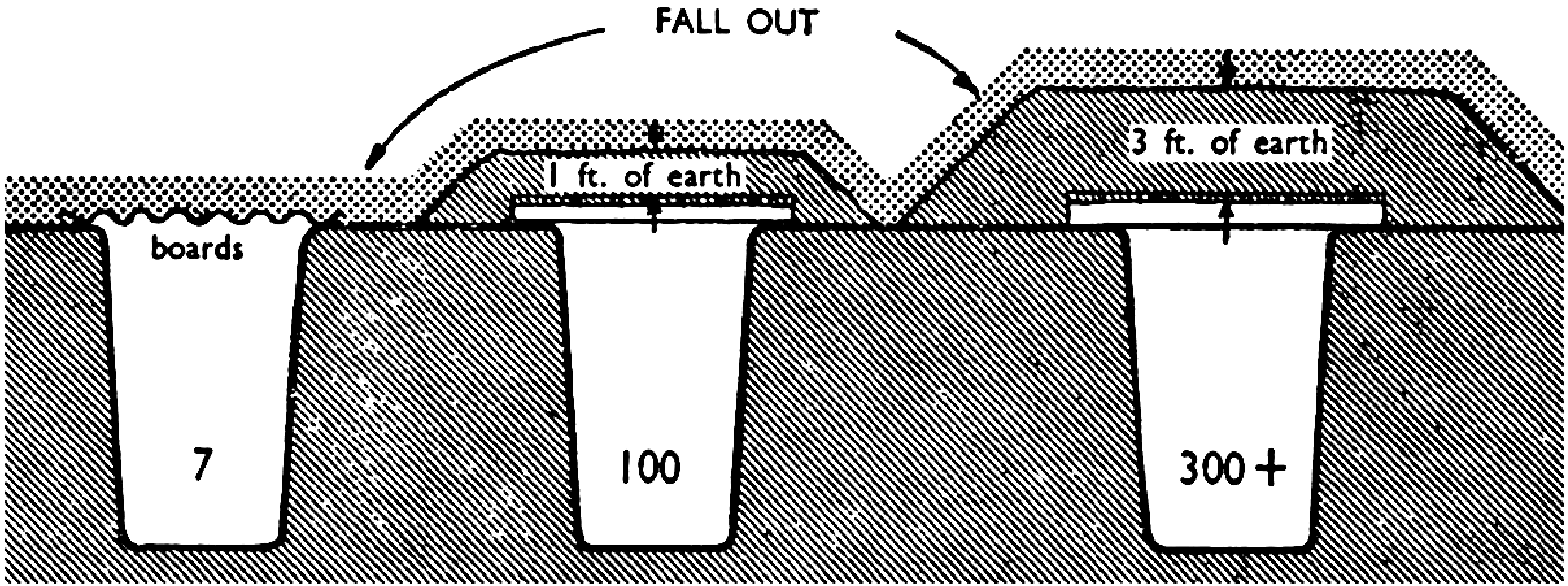




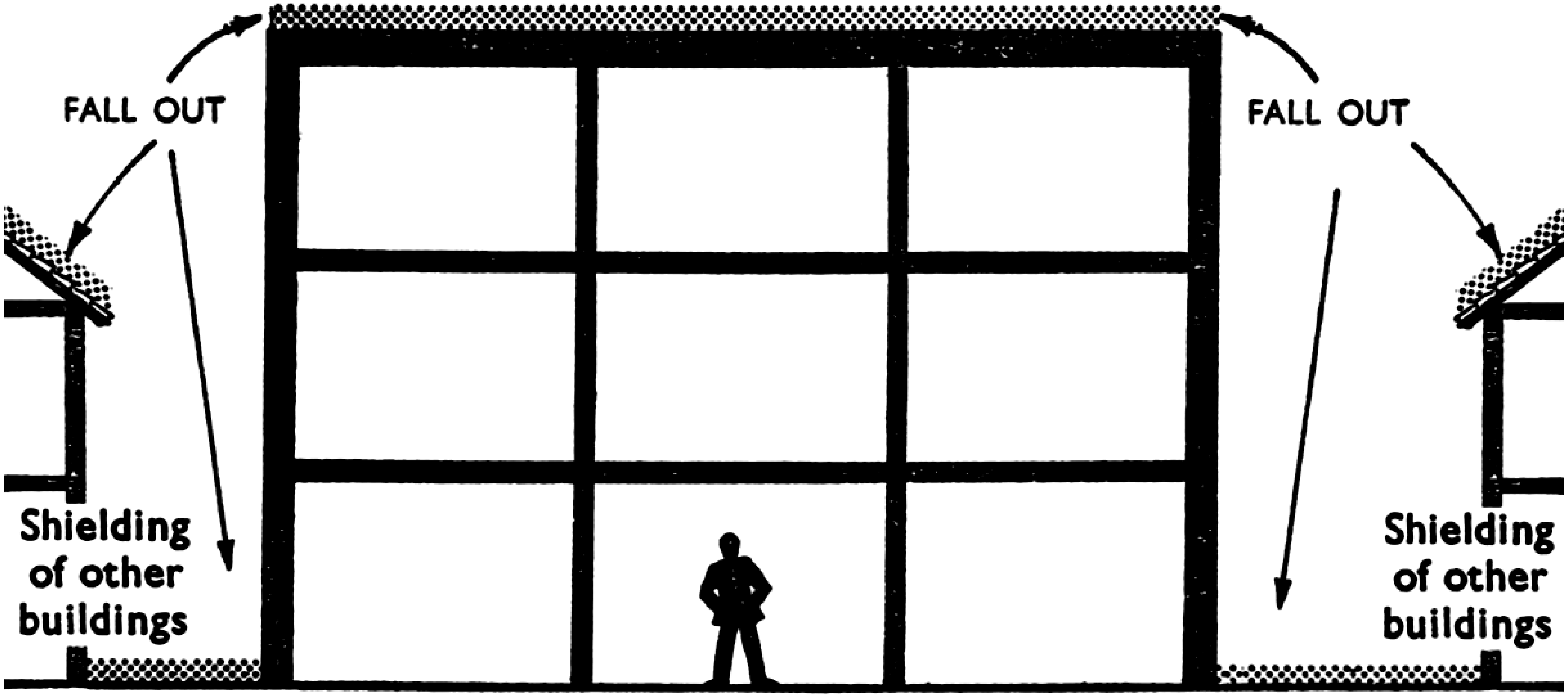
Protection factors in slit trenches (the factor by which the outside dose is divided to get the inside dose).

Choosing a refuge room

In choosing a refuge room in a house one would select a room with a minimum of outside walls and make every effort to improve the protection of such outside walls as there were. In particular the windows would have to be blocked up, e.g. with sandbags.

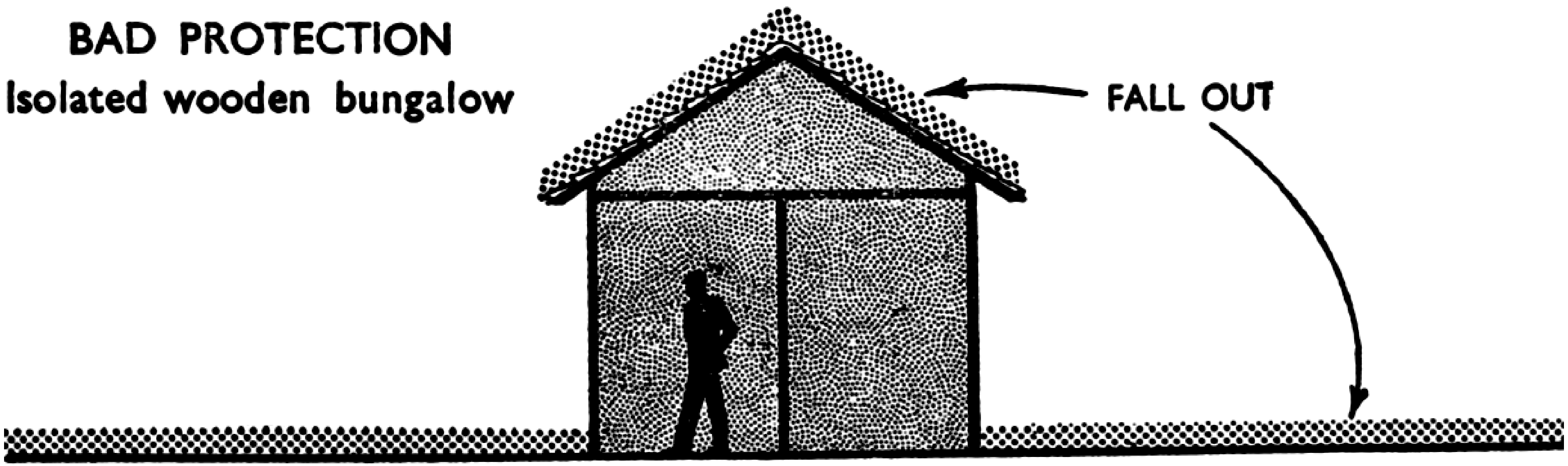
GOOD PROTECTION

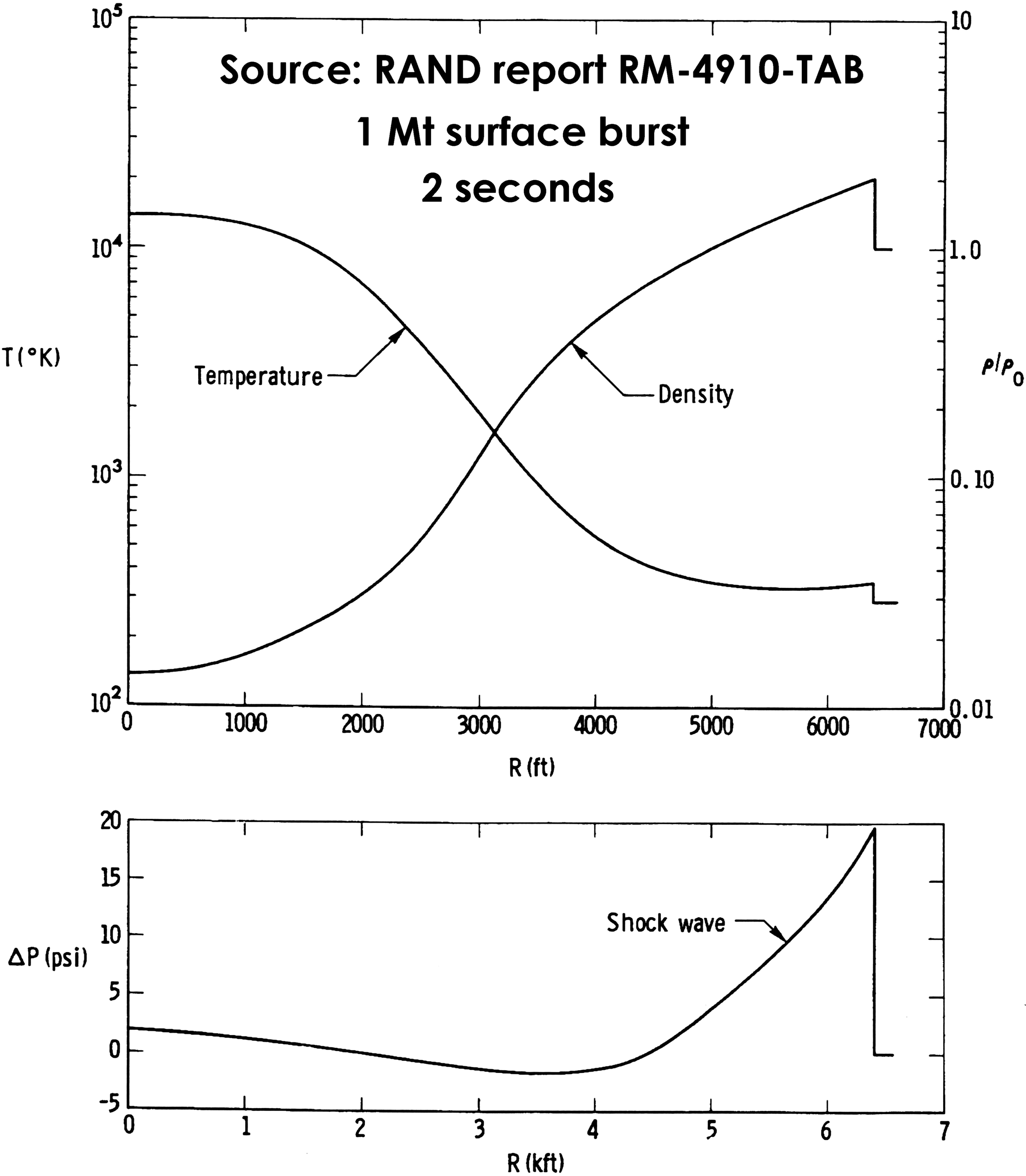
Solidly constructed multi-storeyed building



BAD PROTECTION

Isolated wooden bungalow





Source: RAND report RM-4910-TAB
1 Mt surface burst
2 seconds
T (°K)
Temperature
Density
ρ/ρ0
R (ft)
ΔP (psi)
Shock wave
R (kft)

The Effects of

Nuclear Weapons

Samuel Glasstone

Editor

Revised Edition

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Foreword

This book is a revision of "The Effects of Nuclear Weapons" which was issued in 1957. It was prepared by the Defense Atomic Support Agency of the Department of Defense in coordination with other cognizant governmental agencies and was published by the U.S. Atomic Energy Commission. Although the complex nature of nuclear weapons effects does not always allow exact evaluation, the conclusions reached herein represent the combined judgment of a number of the most competent scientists working on the problem.

There is a need for widespread public understanding of the best information available on the effects of nuclear weapons. The purpose of this book is to present as accurately as possible, within the limits of national security, a comprehensive summary of this information.

Robert S. McNamara

Secretary of Defense

Glenn T. Seaborg

Chairman
Atomic Energy Commission

12.11 In Japan, where little evasive action was taken, the survival probability depended upon whether the individual was outdoors or inside a building and, in the latter case, upon the type of structure. At distances between 0.3 and 0.4 mile (530 and 700 yards) from ground zero in Hiroshima the average survival rate, for at least 20 days after the nuclear explosion, was less than 20 percent. Yet in two reinforced-concrete office buildings, at these distances, almost 90 percent of the nearly 800 occupants survived more than 20 days, although some died later from radiation injury.

These facts bring out clearly the greatly improved chances of survival from a nuclear explosion that could result from the adoption of suitable warning and protective measures.

TABLE 12.29—ARRIVAL TIME FOR PEAK OVERPRESSURE

Distance (miles)	*Explosion yield*				
	1 KT	*10 KT*	*100 KT*	*1 MT*	*10 MT*
	(Time in seconds)				
1	4. 3	3. 6	3. 7	2. 5	1. 5
2	9	8. 1	7. 4	6. 5	5. 0

12.35. The major part of the thermal radiation travels in straight lines, and so any opaque object interposed between the fireball and the exposed skin will give some protection. This is true even if the object is subsequently destroyed by the blast, since the main thermal radiation pulse is over before the arrival of the blast wave.

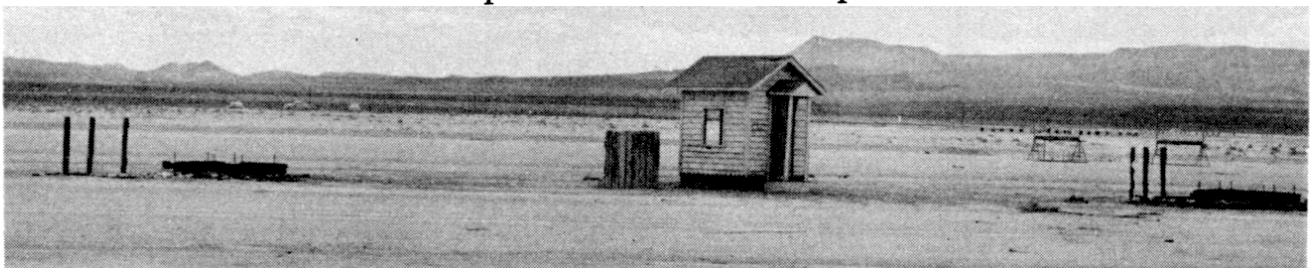
12.36 At the first indication of a nuclear explosion, by a sudden increase in the general illumination, a person inside a building should immediately fall prone, as described in § 12.30, and, if possible, crawl behind or beneath a table or desk or to a planned vantage point.

12. 72 Because of its particulate nature, fallout will tend to collect on horizontal surfaces, e.g., roofs, streets, tops of vehicles, and the ground. In the preliminary decontamination, therefore, the main effort should be directed toward cleaning such surfaces. The simplest way of achieving this is by water washing, if an adequate supply of water is available. The addition of a commercial wetting agent (detergent) will make the washing more efficient. The radioactive material is thus tranferred to storm sewers where it is less of a hazard.

Nevada in 1953.

12 calories per square centimeter

before exposure to a nuclear explosion



after exposure to a nuclear explosion

7.59 The value of fire-resistive furnishing in decreasing the number of ignition points was also demonstrated in the tests. Two identical, sturdily constructed houses, each having a window 4 feet by 6 feet facing the point of burst, were erected where the thermal radiation exposure was 17 calories per square centimeter. One of the houses contained rayon drapery, cotton rugs, and clothing, and, as was expected, it burst into flame immediately after the explosion and burned completely. In the other house, the draperies were of vinyl plastic, and rugs and clothing were made of wool. Although much ignition occurred, the recovery party, entering an hour after the explosion, was able to extinguish the fires.

7.76 It should be noted that the fire storm is by no means a special characteristic of nuclear weapons. Similar fire storms have been reported as accompanying large forest fires in the United States, and especially after incendiary bomb attacks in both Germany and Japan during World War II. The high winds are produced largely by the updraft of the heated air over an extensive burning area. They are thus the equivalent, on a very large scale, of the draft of a chimney under which a fire is burning. Because of limited experience, the conditions for the development of fire storms in cities are not well known. It appears, however, that some, although not necessarily all, of the essential requirements are the following: (1) thousands of nearly simultaneous ignitions over an area of at least a square mile, (2) heavy building density, e.g., more than 20 percent of the area is covered by buildings, and (3) little or no ground wind. Based on these criteria, only certain sections—usually the older and slum areas—of a very few cities in the United States would be susceptible to fire storm development.

HANDBOOK

on

CAPABILITIES

of

ATOMIC WEAPONS

10.3 Damage Criteria

10.32 For those items not included in Table VIII, select the listed item most similar in those characteristics discussed previously as being the important factors in determining the extent of damage to be expected. Perhaps the most important item to be remembered when estimating effects on personnel is the amount of cover actually involved. This cover depends on several items; however, one factor is all important, namely, the degree of forewarning of an impending atomic attack. It is obvious that only a few seconds warning is necessary under most conditions in order to take fairly effective cover. The large number of casualties in Japan resulted for the most part from the lack of warning.

TABLE VIII

ITEM	DAMAGE	AIR SHOCK PSI	REMARKS
Artillery Field (75mm or greater)	Severe	40	Damage to Gun and Cradle
	Moderate	30	Damage to Recoil and Carriage
	Light	5	Damage to Gun Sights
Artillery Field (Less than 75mm)	Severe	25	Damage to Gun and Cradle
	Moderate	15	Damage to Recoil and Loading Mechanism
	Light	5	Damage to Sights
Reinforced Concrete Bldgs.	Severe	25	Collapse
	Moderate	10	Structural damage
	Light	3	Plaster & window damage
Steel, heavy frame Bldgs.	Severe	18	Mass distortion
	Moderate	12	Structural Damage
	Light	3	Plaster & window damage
Steel, light frame Bldgs.	Severe	10	Mass distortion
	Moderate	5	Structural Damage
	Light	3	Plaster & window damage

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DEPARTMENT OF THE NAVY — OPNAV INSTRUCTION 03400.1B

DEPARTMENT OF THE AIR FORCE — AFL 136-1

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CAPABILITIES OF ATOMIC WEAPONS (U)

Prepared by

Armed Forces Special Weapons Project

DEPARTMENTS OF THE ARMY, THE NAVY AND THE AIR FORCE

REVISED EDITION NOVEMBER 1957

~~CONFIDENTIAL~~

Personnel in structures. A major cause of personnel casualties in cities is structural collapse and damage. The number of casualties in a given situation may be reasonably estimated if the structural damage is known. Table 6–1 shows estimates of casualty production in two types of buildings for several damage levels. Data from Section VII may be used to predict the ranges at which specified structural damage occurs. Demolition of a brick house is expected to result in approximately 25 percent mortality, with 20 percent serious injury and 10 percent light injury. On the order of 60 percent of the survivors must be extricated by rescue squads. Without rescue they may become fire or asphyxiation casualties, or in some cases be subjected to lethal doses of residual radiation. Reinforced concrete structures, though much more resistant to blast forces, produce almost 100 percent mortality on collapse. The figures of table 6–1 for brick homes are based on data from British World War II experience. It may be assumed that these predictions are reasonably reliable for those cases where the population is in a general state of expectancy of being subjected to bombing and that most personnel have selected the safest places in the buildings as a result of specific air raid warnings. For cases of no prewarning or preparation, the number of casualties is expected to be considerably higher.

6–2

Glass breakage extends to considerably greater ranges than almost any other structural damage, and may be expected to produce large numbers of casualties at ranges where personnel are relatively safe from other effects, particularly for an unwarned population.

Table 6–1. Estimated Casualty Production in Structures for Various Degrees of Structural Damage

	Killed outright	Serious injury (hospitalization)	Light injury (No hospitalization)
1–2 story brick homes (high explosive data):	*Percent*	*Percent*	*Percent*
Severe damage	25	20	10
Moderate damage	<5	10	5
Light damage	......	<5	<5

Note. These percentages do not include the casualties which may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentage of casualties expected at the maximum range where the specified structural damage occurs.

Personnel in a prone position are less likely to be struck by flying missiles than those who remain standing.

6–3

Table 6–2. Critical Radiant Exposures for Burns Under Clothing

(Expressed in cal/cm² incident on outer surface of cloth)

Clothing	Burn	1 KT	100 KT	10 MT
Summer Uniform	1°	8	11	14
(2 layers)	2°	20	25	35
Winter Uniform	1°	60	80	100
(4 layers)	2°	70	90	120

6–4

3.1 General

For a surface burst having the same yield as an air burst, the presence of the earth's surface results in a reduced thermal radiation emission and a cooler fireball when viewed from that surface. This is due primarily to heat transfer to the soil or water, the distortion of the fireball by the reflected shock wave, and the partial obscuration of the fireball by dirt and dust (or water) thrown up by the blast wave.

$$Q = \frac{3.16 \times 10^6 \, W \, (\overline{T})}{D^2} \text{ cal/sq cm (air burst).}$$

and

$$Q = \frac{1.35 \times 10^6 \, W \, (\overline{T})}{D^2} \text{ cal/sq cm (surface burst).}$$

where Q=radiant exposure (cal/sq cm)
$\overline{T}$=atmospheric transmissivity
W=weapon yield (KT)
D=slant range (yds).

~~CONFIDENTIAL~~ 3–1

Measurements from the ground of the total thermal energy from surface bursts, although not as extensive as those for air bursts, indicate that the thermal yield is a little less than half that from equivalent air bursts. For a surface burst the thermal yield is assumed to be one-seventh of the total yield.

3–2 ~~CONFIDENTIAL~~

~~CONFIDENTIAL~~ 3–3

The differences between the air burst and surface burst curves are caused by the difference in apparent radiating temperatures (when viewed from the ground) and the difference in geometrical configuration of the two types of burst.

50 mile visibility and 5 gm/m³ water vapor.
10 mile visibility and 10 gm/m³ water vapor.

3.3 Radiant Exposure vs. Slant Range

a. Spectral. Characteristics. At distances of operational interest, the spectral (wavelength) distribution of the incident thermal radiation, integrated with respect to time, resembles very closely the spectral distribution of sunlight. For each, slightly less than one-half of the radiation occurs in the visible region of the spectrum, approximately one-half occurs in the infrared region and a very small fraction (rarely greater than 10 percent) lies in the ultraviolet region of the spectrum. The color temperature of the sun and an air burst are both about 6,000° K. A surface burst, as viewed by a ground observer, contains a higher proportion of infrared radiation and a smaller proportion of visible radiation than the air burst, with almost no radiation in the ultraviolet region. The color temperature for a surface burst is about 3,000° K. A surface burst viewed from the air may exhibit a spectrum more nearly like an air burst.

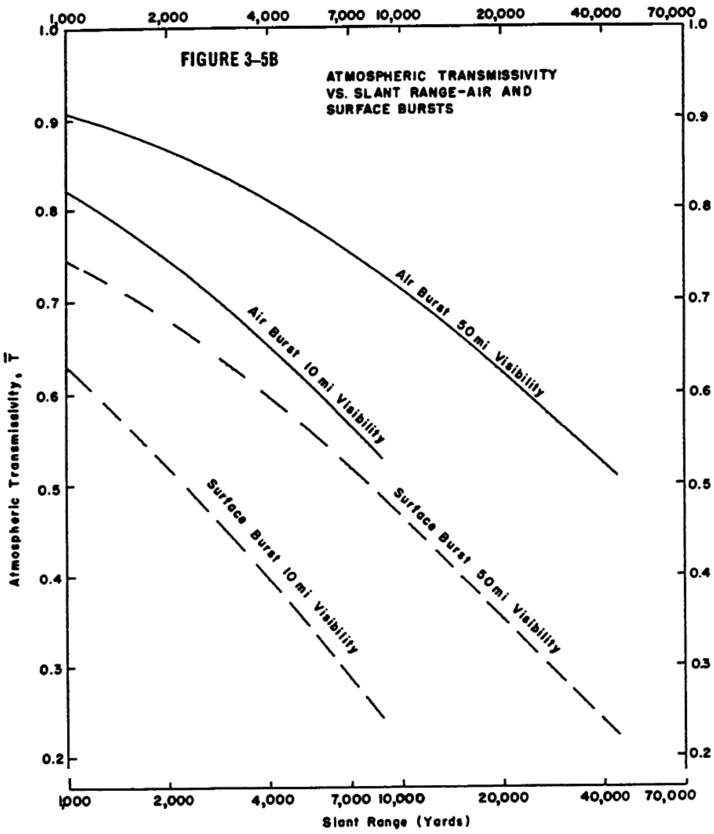


Table 12–2. Critical Radiant Exposure Values for Various Materials

Material	Damage	Critical radiant exposure Q_c (cal/sq cm)		
		1 KT	100 KT	10 MT
Sandbags: Cotton canvas, dry, filled	Failure	10	18	32
Wood, white pine	0.1 mm depth char	10	18	32
White pine, given protective coating	0.1 mm depth char	40	71	126

SECTION VII
DAMAGE TO STRUCTURES

7.1 General

Tunnels in solid rock are difficult to destroy by explosions of nuclear weapons. In this case, the shock wave is transmitted through the rock. When it reaches the tunnel the wave is reflected as a tensile wave, and there is a tendency for the rock to spall or become detached from the rock-tunnel interface. Use of tunnel linings materially reduces this spalling. Mass crushing of the rock and filling of the tunnel occurs closer to the burst point.

7.4 Field Fortifications

a. Air Blast. Air blast is the controlling damage-producing mechanism for destruction of field fortifications, including those reinforced, revetted or covered. Definitions of severe, moderate, and light damage levels to various types of field fortifications are given in table 7–4. These damage levels are based upon various degrees of collapse and structural failure except for unrevetted trenches and foxholes, which have damage levels based on degree of filling caused by collapse of the walls and by filling with dust and debris. Areas covered with loose material, such as sand and gravel, may provide sufficient dust and debris to completely fill a trench or foxhole, whereas areas with stable vegetation or areas of dry silty soil may not provide significant quantities of dust and debris to appreciably fill a trench or foxhole. Collapse of the walls of foxholes and trenches by air blast and air induced ground shock is usually not significant except at ranges less than those shown for severe damage in figure 7–22.

Table 7–4. Damage Criteria for Field Fortifications

Description	Severe
Unrevetted trenches and foxholes with or without light cover.	The trench or foxhole is at least 50 percent filled with earth.

FIGURES 7-20—7-22

The curves in figure 7–22 are based on results of tests run in a *consolidated dry sand and gravel soil*. Trenches and foxholes in damp soil with stable vegetation or dry silty soil will receive moderate and severe damage at ranges less than those shown in figure 7–22. The curves of figure 7–22 are for average rectangular foxholes with the longitudinal axis perpendicular to the direction of air blast propagation. Damage will be equal or less for other orientations.

Given: A 50 KT burst at an altitude of 1,000 feet.

Find: To what horizontal distance there is a 50 percent probability of severe damage to an unrevetted foxhole in a dry, consolidated sand and gravel soil.

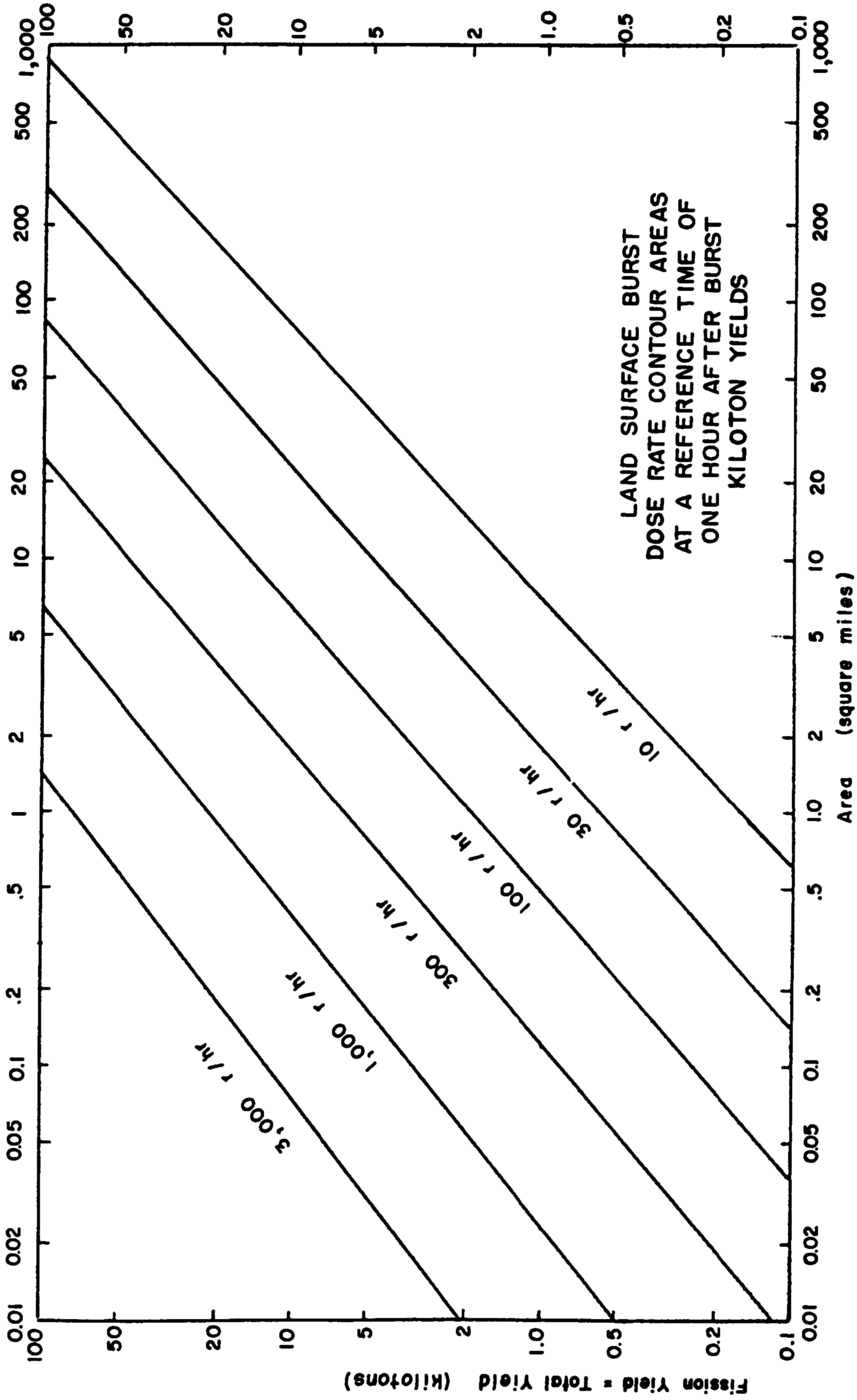
Solution: 680 yards.

Approximately 20 psi peak overpressure

Table 7–3. Damage Criteria for Underground Structures

Structure	Damage	Damage distance	Remarks
Relatively small, heavy, well designed underground targets.	Severe	$1\frac{1}{4}R_a$	Collapse.
	Light	$2R_a$	Slight cracking, severance of brittle external connections.
Relatively long, flexible targets, such as buried pipelines, tanks, etc.	Severe	$1\frac{1}{2}R_a$	Deformation and rupture.
	Moderate	$2R_a$	Slight deformation and rupture.
	Light	$2\frac{1}{2}$ to $3R_a$	Failure of connections. (Use higher value for radial orientation of connections.)

Note. R_a=Apparent Crater Radius.


LAND SURFACE BURST
DOSE RATE CONTOUR AREAS
AT A REFERENCE TIME OF
ONE HOUR AFTER BURST
KILOTON YIELDS
10 r / hr
30 r / hr
100 r / hr
300 r / hr
1,000 r / hr
3,000 r / hr
Area (square miles)
0.01
0.02
0.05
0.1
.2
.5
1
2
5
10
20
50
100
200
500
1,000
Fission Yield = Total Yield (kilotons)
100
50
20
10
5
2
1.0
0.5
0.2
0.1

DNA EM-1
PART I

DEFENSE NUCLEAR AGENCY EFFECTS MANUAL NUMBER 1

CAPABILITIES OF NUCLEAR WEAPONS

1 JULY 1972

HEADQUARTERS
Defense Nuclear Agency
Washington, D.C. 20305

FOREWORD

This edition of the *Capabilities of Nuclear Weapons* represents the continuing efforts by the Defense Nuclear Agency to correlate and make available nuclear weapons effects information obtained from nuclear weapons testing, small-scale experiments, laboratory effort and theoretical analysis. This document presents the phenomena and effects of a nuclear detonation and relates weapons effects manifestations in terms of damage to targets of military interest. It provides the source material and references needed for the preparation of operational and employment manuals by the Military Services.

The *Capabilities of Nuclear Weapons* is not intended to be used as an employment or design manual by itself, since more complete descriptions of phenomenological details should be obtained from the noted references. Every effort has been made to include the most current reliable data available on 31 December 1971 in order to assist the Armed Forces in meeting their particular requirements for operational and target analysis purposes.

Comments concerning this manual are invited and should be addressed:

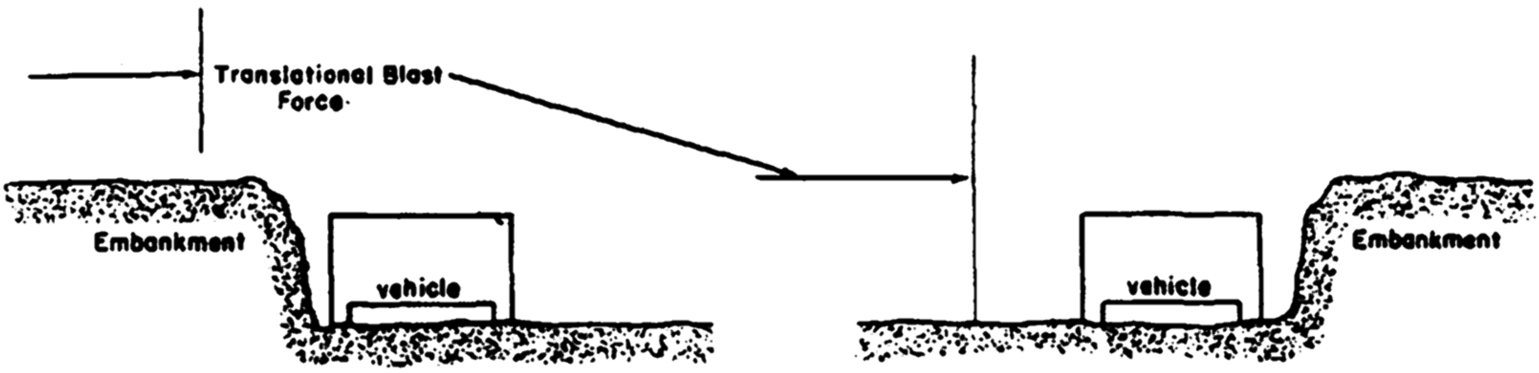
Director
Defense Nuclear Agency
ATTN: STAP
Washington, D. C. 20305

C. H. DUNN
Lt General, USA
Director

Table 10-1 Estimated Casualty Production in Buildings for Three Degrees of Structural Damage

Structural Damage	Percent of Personnel*		
	Killed Outright	Serious Injury (hospitalization)	Light Injury (no hospitalization)
1-2 story brick homes (high-explosive data from England):			
Severe damage	25	20	10
Moderate damage	<5	10	5
Light damage	–	<5	<5
Reinforced-concrete buildings (nuclear data from Japan):			
Severe damage	100	–	–
Moderate damage	10	15	20
Light damage	<5	<5	15

*These percentages do not include the casualties that may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentages of casualties expected at the maximum range where a specified structural damage occurs. See Chapter 11 for the distances at which these degrees of damage occur for various yields.



(a) No translation because Translational Force is not applied

(b) No or little translation because embankment restricts movement

Figure 14-8. The Effect of Shielding

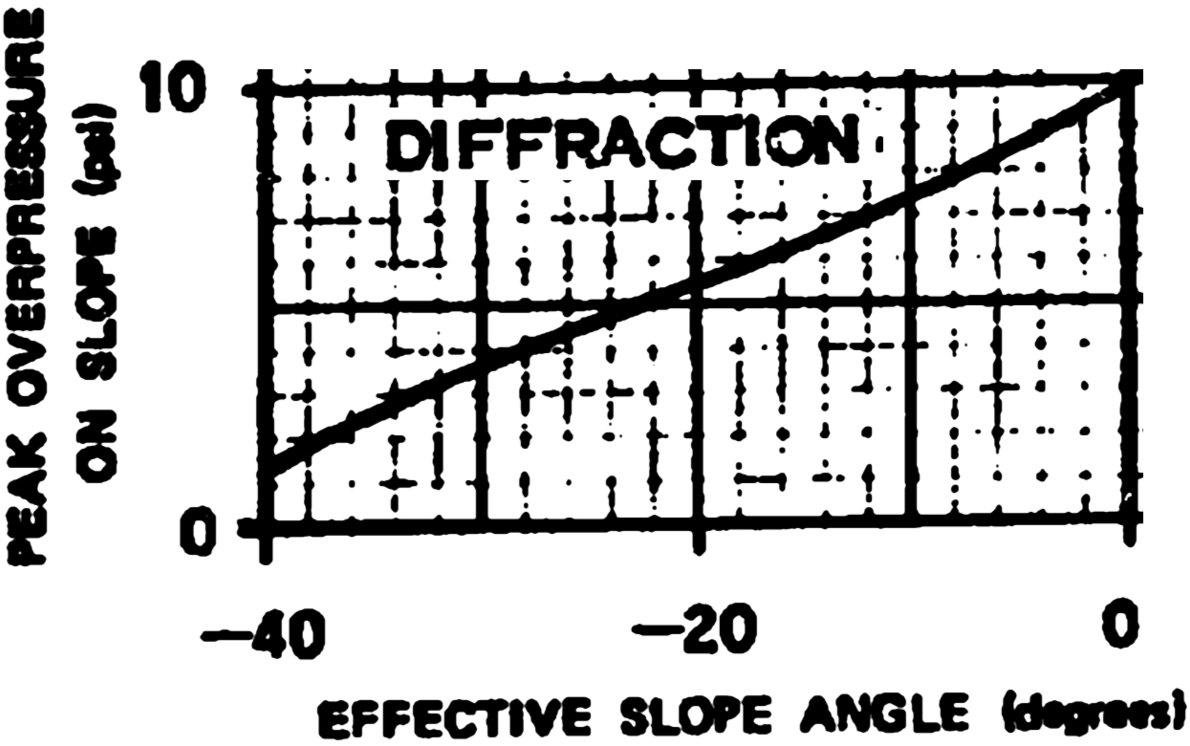


Figure 2-53. Peak Overpressure Produced on a Slope by a 10-psi Incident Mach Stem as a Function of a Slope Angle

If the pulse is of long duration, the ignition threshold rises because the exposed material can dissipate an appreciable fraction of the energy while it is being received. For very long rectangular pulses an irradiance of about 0.5 cal $\cdot$ $cm^{-2} sec^{-1}$ is required to ignite the cellulose. Heat supplied to the material at a slow rate is just sufficient to offset radiative and convective heat losses, while maintaining the cellulose at the ignition temperature of about 300°C.

9-19

Most thick, dense materials that ordinarily are considered inflammable do not ignite to persistent flaming ignition when exposed to transient thermal radiation pulses. Wood, in the form of siding or beams, may flame during the exposure but the flame is extinguished when the exposure ceases.

9-25

MINISTRY OF HOME SECURITY

AIR RAIDS

What You must know
What You must do

LONDON: H. M. STATIONERY OFFICE

Price 3d. Net or 10s. for 50.

FOREWORD

BY

SIR JOHN ANDERSON, G.C.B., G.C.S.I., G.C.I.E., M.P.

Minister of Home Security.

This book is written to help you and your family and your friends.

There has been built up in the last few years a vast organisation for Civil Defence; and, thanks to the devotion of a great army of volunteers, the services which it comprises have been welded into a highly efficient force. This organisation is briefly described in the first chapter, which has been included in this book for two reasons; first, because I may, in the near future, have to call on many of you to give some part of your time to one or other of these services, and secondly, because you may need the help of the services and should therefore understand something about them.

But the Civil Defence services alone cannot protect you from the consequences of air raids. Your own protection and the protection of your family must, in large measure, depend on your taking certain necessary precautions. You can yourself do much to minimise risk to yourself and to those dependent on you.

A great deal of information has been collected as a result of experience gained in actual air raids, and from this and from research and experiment the basic principles on which the protection of life and limb and property depends have been worked out and are set down here for your guidance. They are simple to understand and easy to carry out; and if you will act on them you will be able to face the dangers of air raids with the sure conviction that you have done all in your power for the safety of those depending on you, and with the calmness and assurance that come from a knowledge of the way in which these dangers can be met. In this way you will be helping not only yourself, but the Nation, for it is through the strengthening of your powers of resistance that the people of this country will be enabled to defeat every attempt the enemy may make to weaken its morale and paralyse its war effort.

In this war every man and woman is in the front line. A soldier at the front who neglects the proper protection of his trench does more than endanger his own life; he weakens a portion of his country's defences and betrays the trust which has been placed in him. You, too, will have betrayed your trust if you neglect to take the steps which it is your responsibility to take for the protection of yourself and your family.

This is a contribution to the winning of final victory which you personally can make and which no one else can make for you. I am confident that you will make it.

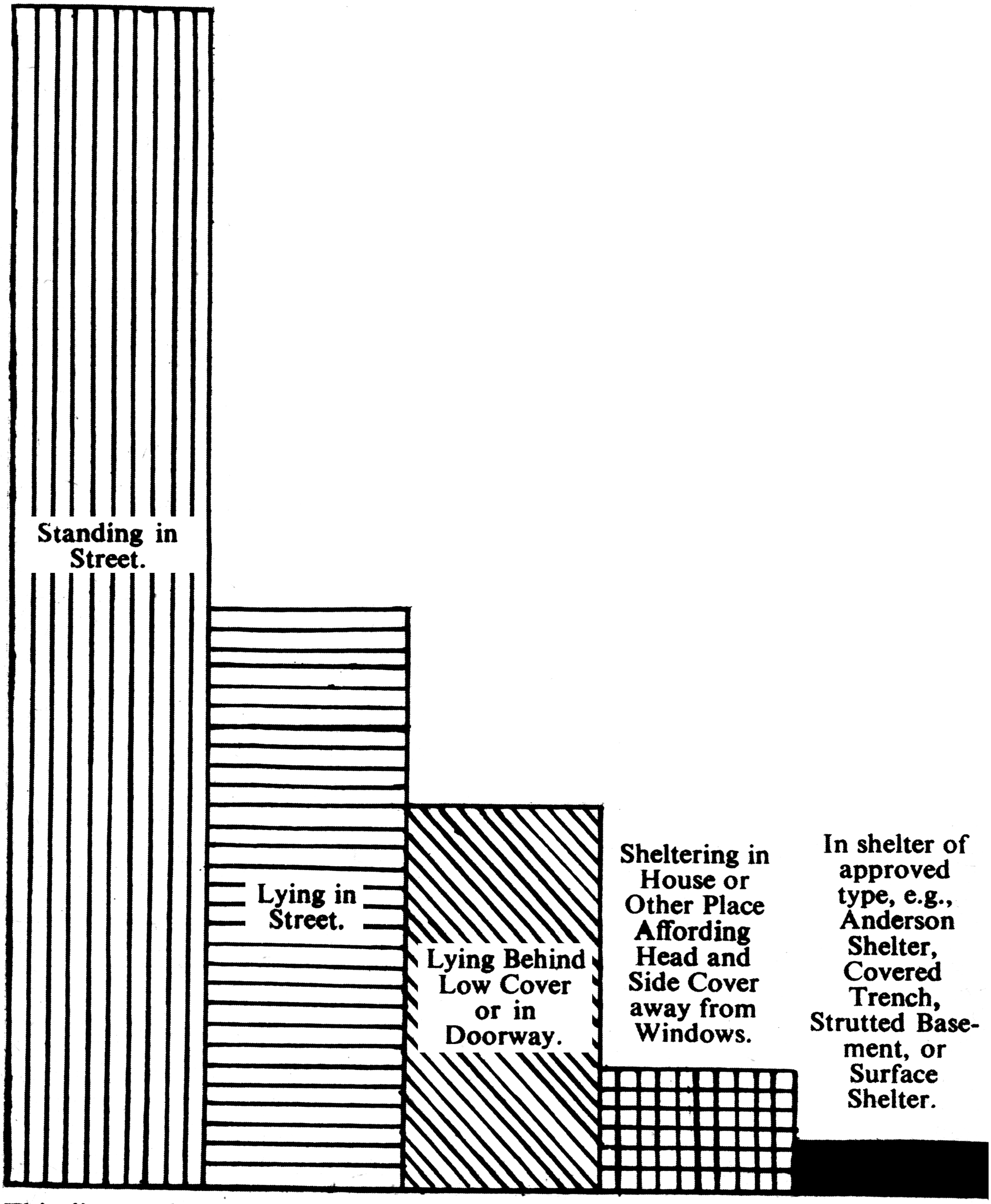
John Anderson

Ministry of Home Security.

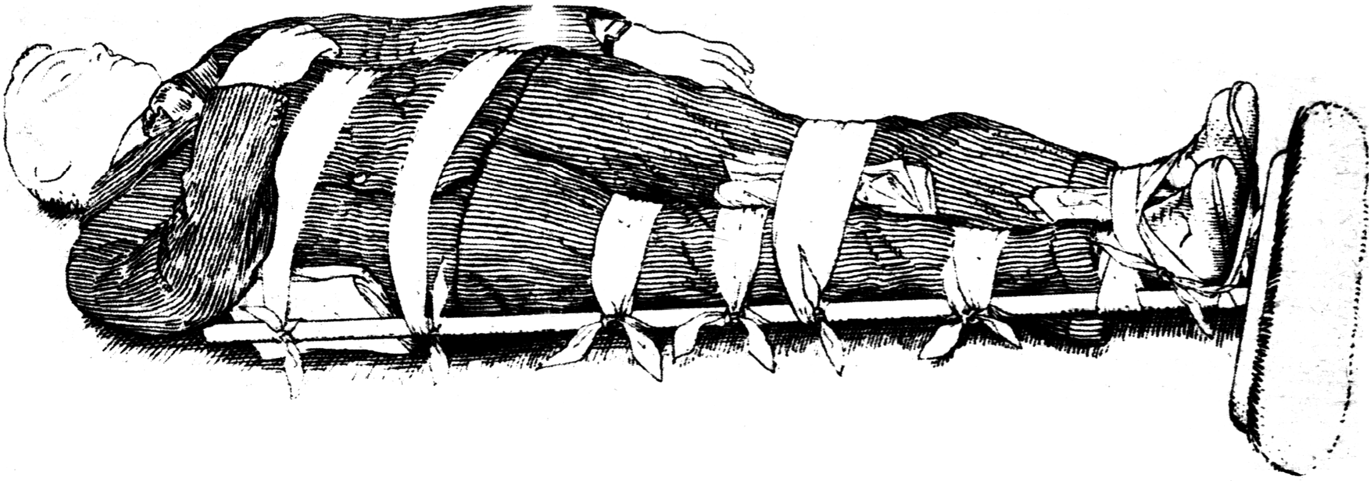
June, 1940.

Tools.

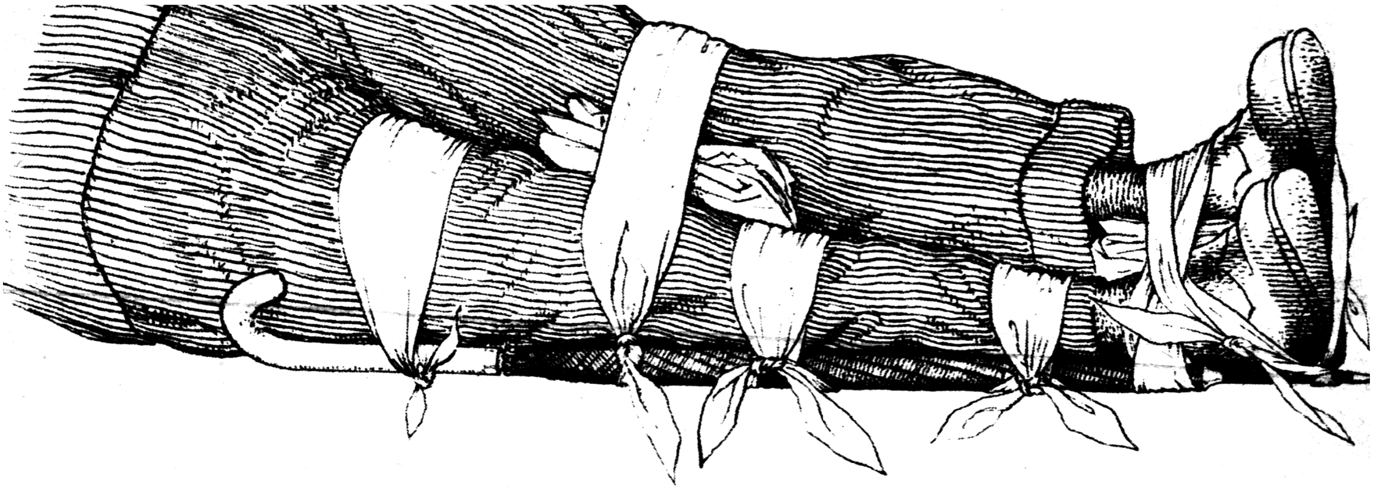
A number of tools such as picks, shovels, and crowbars should be kept in a shelter to be used in forcing a way out if the occupants are trapped. When the accommodation is being fitted out, it should be discovered where the weakest part of the structure is, or where it would be most suitable to work, should it become necessary to break a way out. This position should be clearly marked for the benefit of all.



This diagram is based on a large number of reports of the results of recent air raids and is an approximate indication of the difference in the degree of risk resulting from taking cover in various ways.

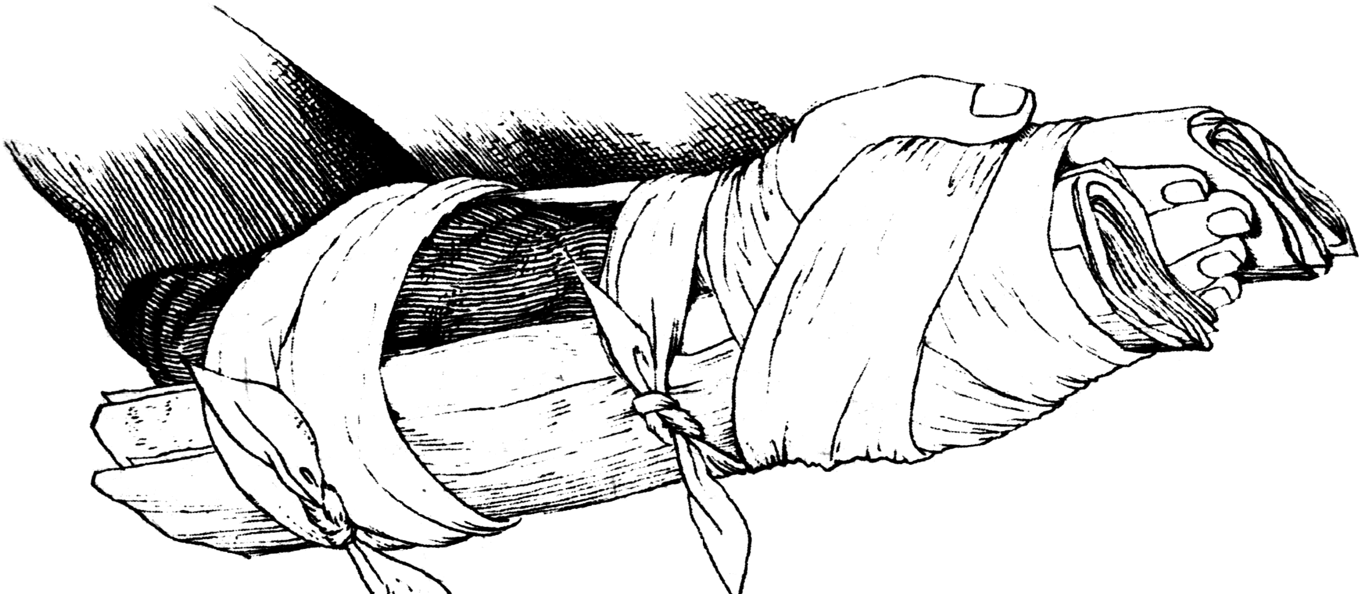


A broom used as a thigh splint by placing the handle along the injured limb, with the head of the broom at the feet. Loosely folded pieces of newspaper or other material may be used as padding, placed between the ankle and knee joints, and also at the hip.



Sketch II.—Simple fracture through middle third of tibia (shin-bone).

The illustration shows an umbrella used as a splint. The ankles and knee joints are padded with loosely folded newspaper.



Sketch III. **Simple fracture through one or both bones of the forearm.**

The illustration shows the use of newspaper, folded to the approximate size of an arm splint, so as to be stiff enough to give rigid support.

AN ANALYSIS OF 259 OF THE RECENT FLYING-BOMB CASUALTIES

BY

R. C. BELL, M.B., M.R.C.S.

Resident Surgical Officer to an E.M.S. Hospital

In all we dealt with 222 out-patients and 259 in-patients, with 18 deaths. Our story began in June, 1944, when the first large incident occurred near by. Twenty-six casualties were admitted and 12 required theatre treatment. This proportion remained fairly constant throughout the series. Altogether we had 83 theatre cases out of 259 admissions, and had to send 35 cases on untreated, most of whom required the theatre. In this first incident no fewer than 16 of the casualties were due to flying glass. It was noticeable how the proportion of glass injuries dropped as the importance of taking adequate cover was realized, while the percentage of crush injuries increased from people being trapped by falling masonry.

A. Flying Glass

This was the most frequent cause of injury, totalling over 100 casualties in all. Many included severe damage to the eyes. It is noticeable that most of the injuries were above the nipple line, chiefly of the face and neck: a large proportion were received when looking out of windows—a modern version of curiosity killing the cat. We had five cases of perforating wounds of both eyes and ten perforating wounds of one eye. The globe was usually completely destroyed. Many of these injuries were avoidable, and therein lay their great sadness.

The penetrating power of flying glass is, in the main, low. It is unusual for it to pierce the deep fascia: usually it lies just under the skin in the fat, but when present in hundreds of pieces it presents a problem which has not yet acquired a satisfactory solution ; nor has the condition made its way into the textbooks of war surgery.

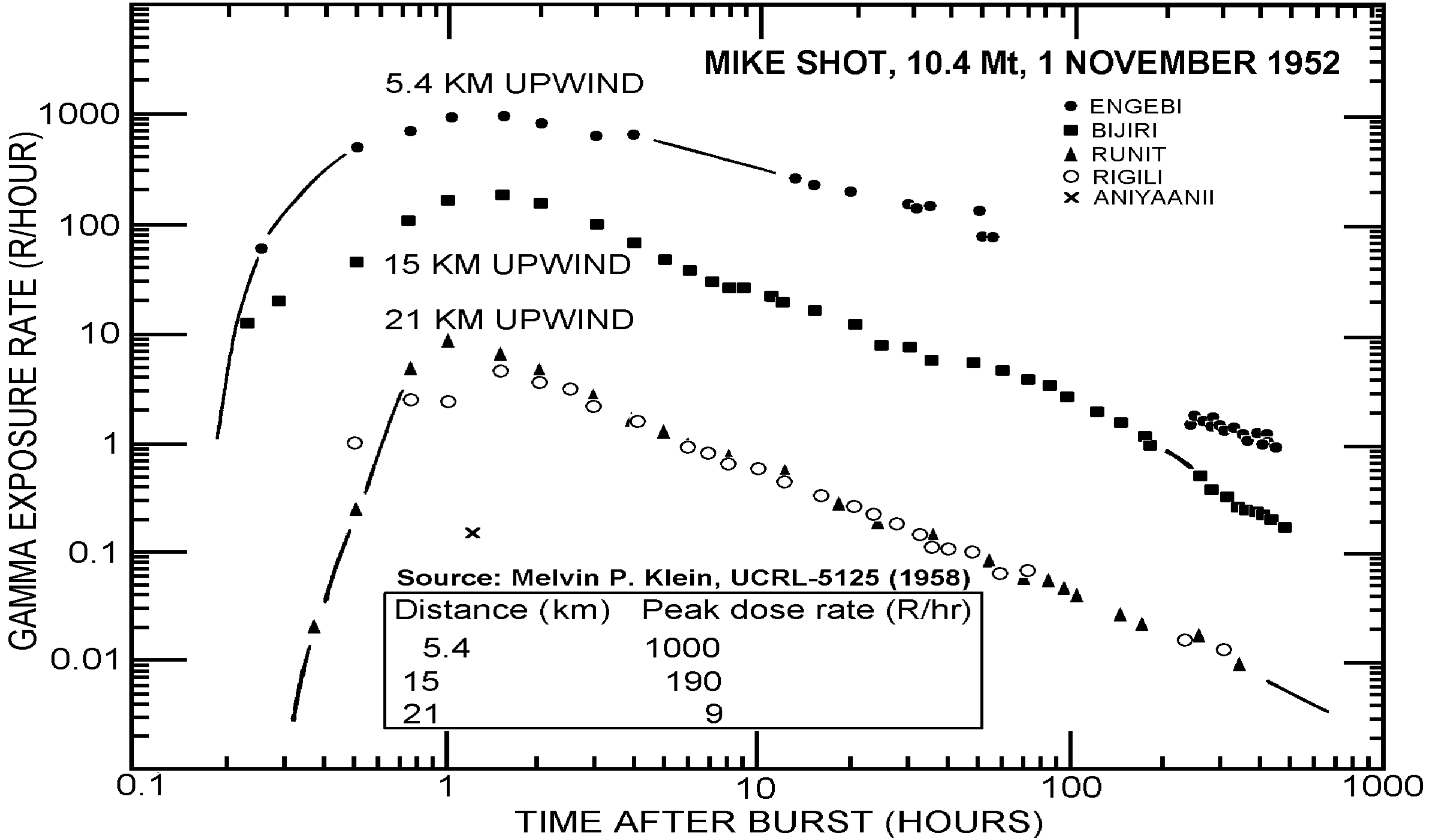
TABLE I.—*Glass*

Description	No.	Remarks	Deaths
Lacerations of face, scalp, and neck ..	77	19 T	—
Perforating wounds of eye	15	5 cases bilateral 2 T	—
Cut hands	9		
Severe multiple lacerations	6	1 T	1
Other injuries	5	—	—

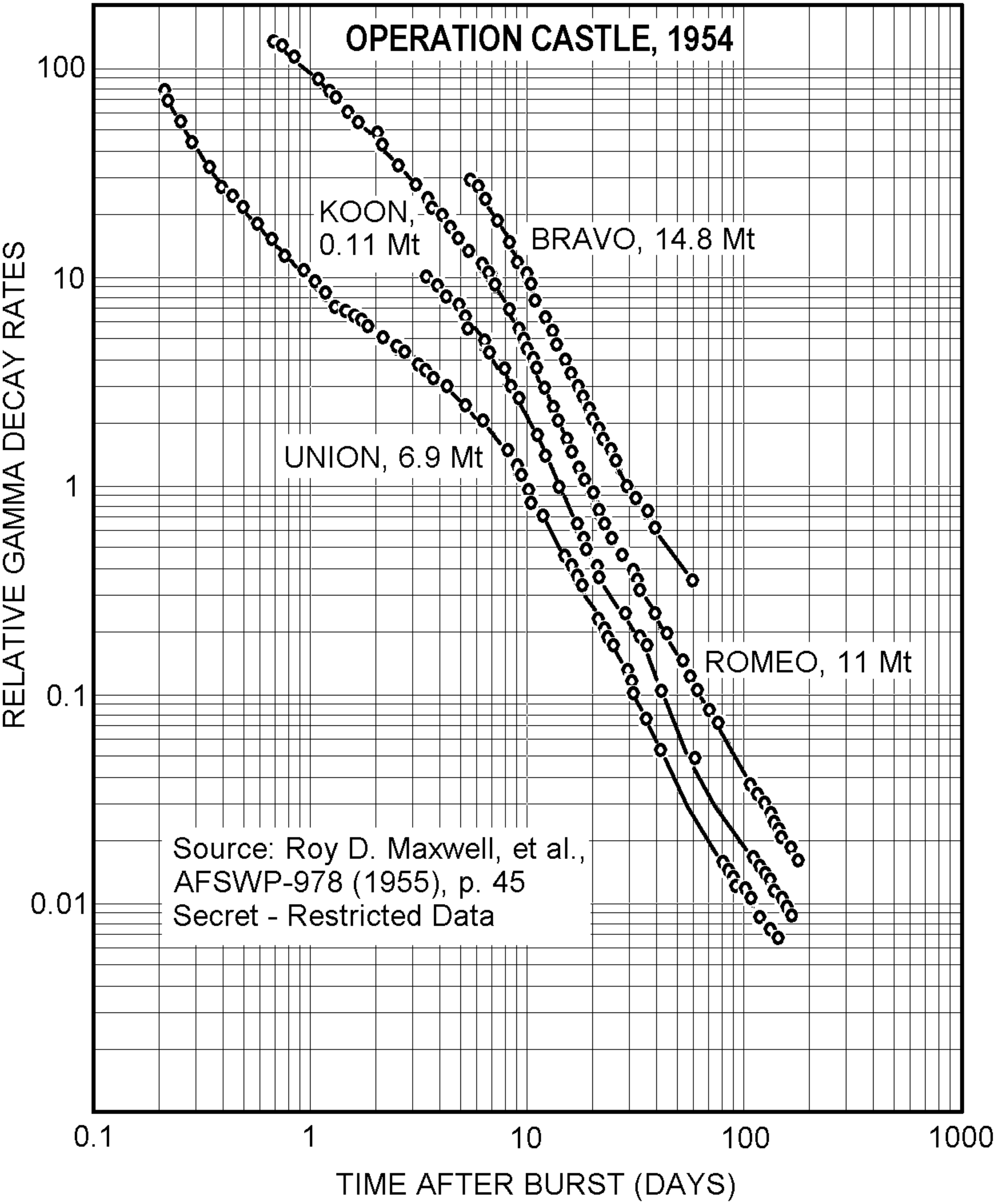
NUMBER AND CLASSIFICATION OF OFFICIAL EVACUEES IN GREAT BRITAIN IN 1939 AND 1940

900,000 of the 1.5 million returned to the target areas after four months of war.	September, 1939		January, 1940	
	Number	Percentage Distribution	Number	Per cent of Those in September, 1939
1. Unaccompanied school children	826,959	56.1	457,600	55
2. Mothers and accompanied children	523,670	35.5	64,900	12
3. Expectant mothers	12,705	0.9	1,140	9
4. Blind persons, cripples, and other special classes	7,057	0.5	2,440	35
5. Teachers and helpers	103,000	7.0	46,500	45
Total	1,473,391	100.0	572,580	39

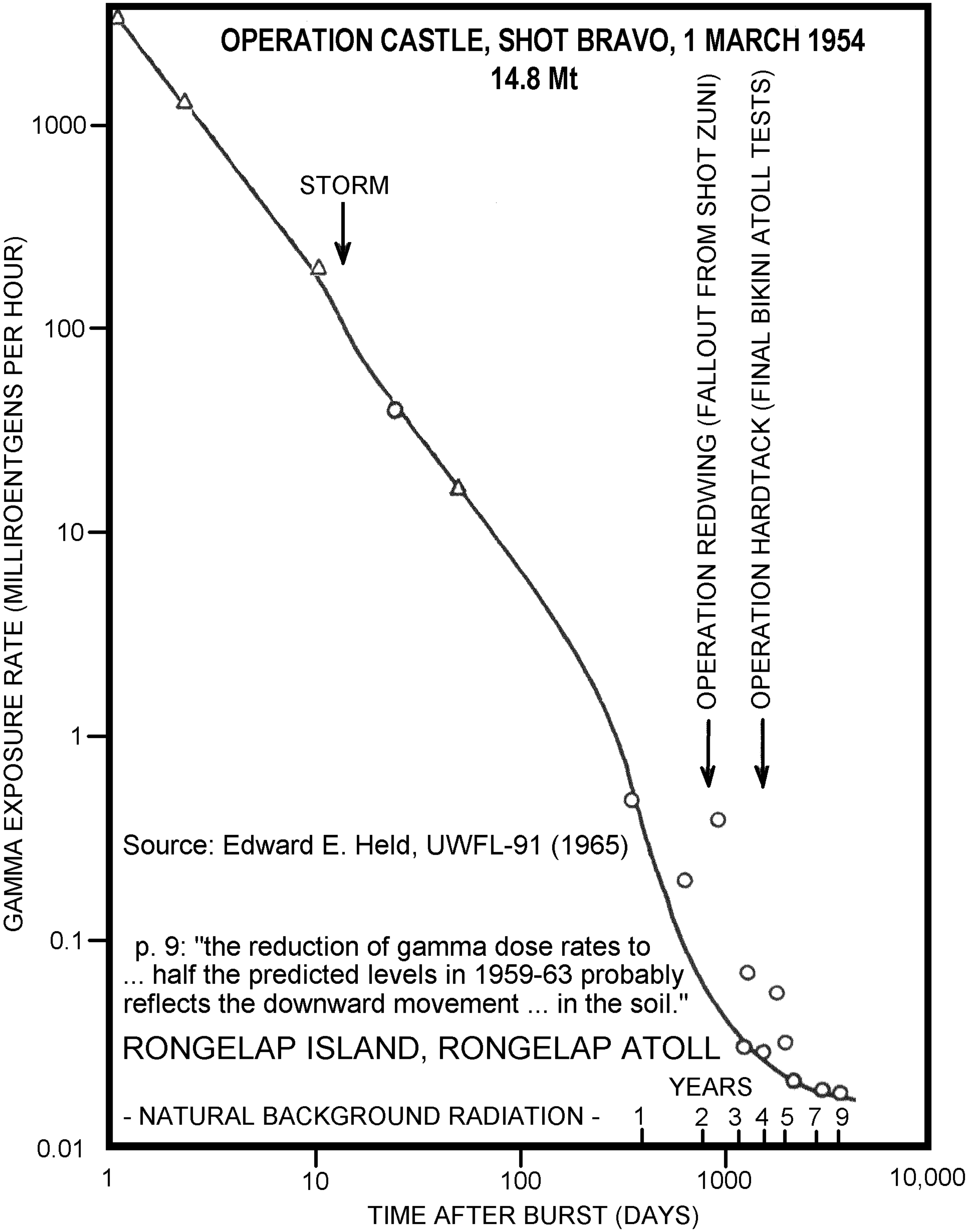
Source: R. M. Titmuss, *Problems of Social Policy* (London: H.M. Stationery Office, 1950), pp. 103 and 172.

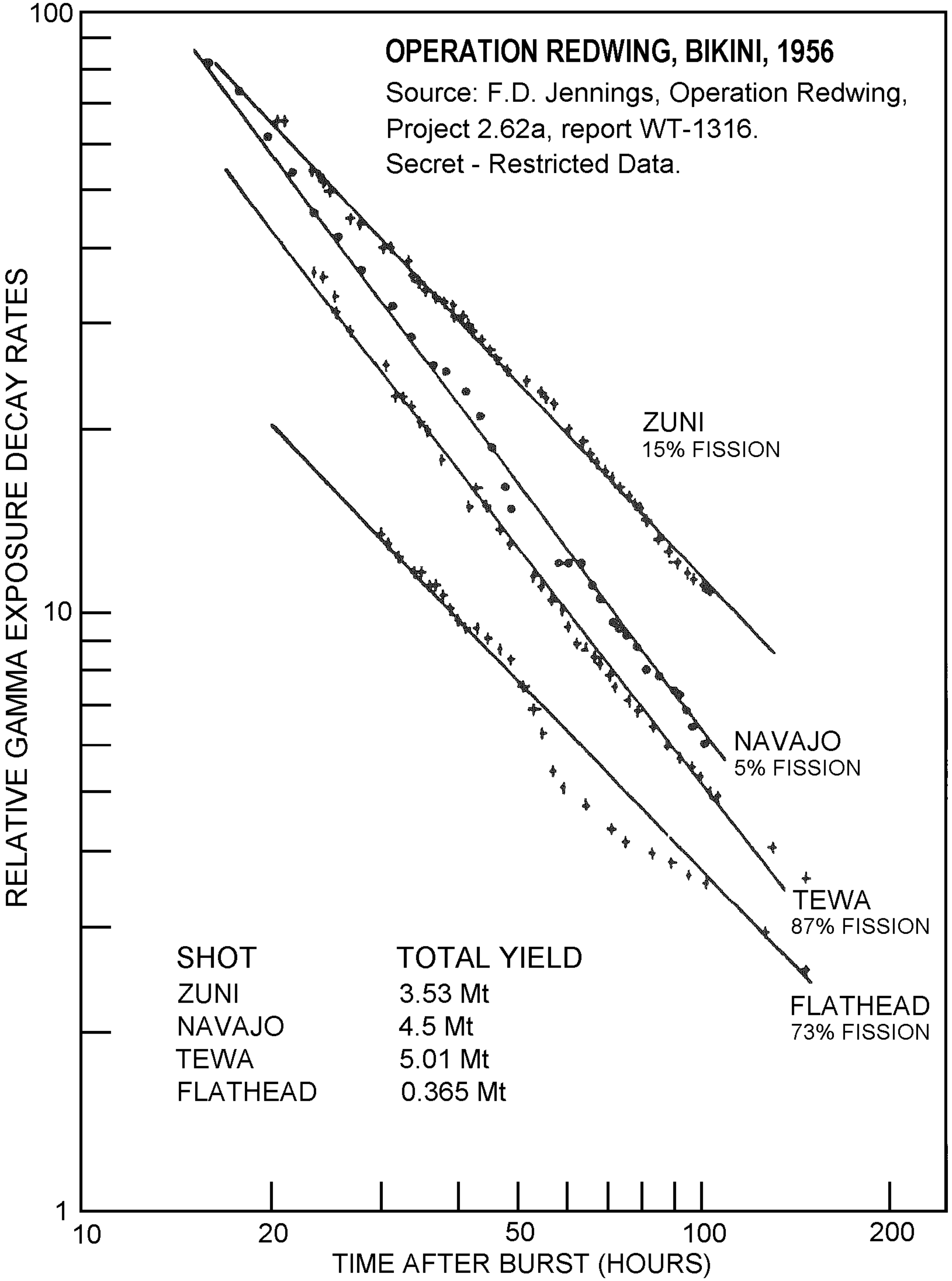


MIKE SHOT, 10.4 Mt, 1 NOVEMBER 1952
ENGEBI
BIJIRI
RUNIT
RIGILI
ANIYAANII
5.4 KM UPWIND
15 KM UPWIND
21 KM UPWIND
Source: Melvin P. Klein, UCRL-5125 (1958)
Distance (km) Peak dose rate (R/hr)
5.4 1000
15 190
21 9
GAMMA EXPOSURE RATE (R/HOUR)
1000
100
10
1
0.1
0.01
0.1
1
10
100
1000
TIME AFTER BURST (HOURS)

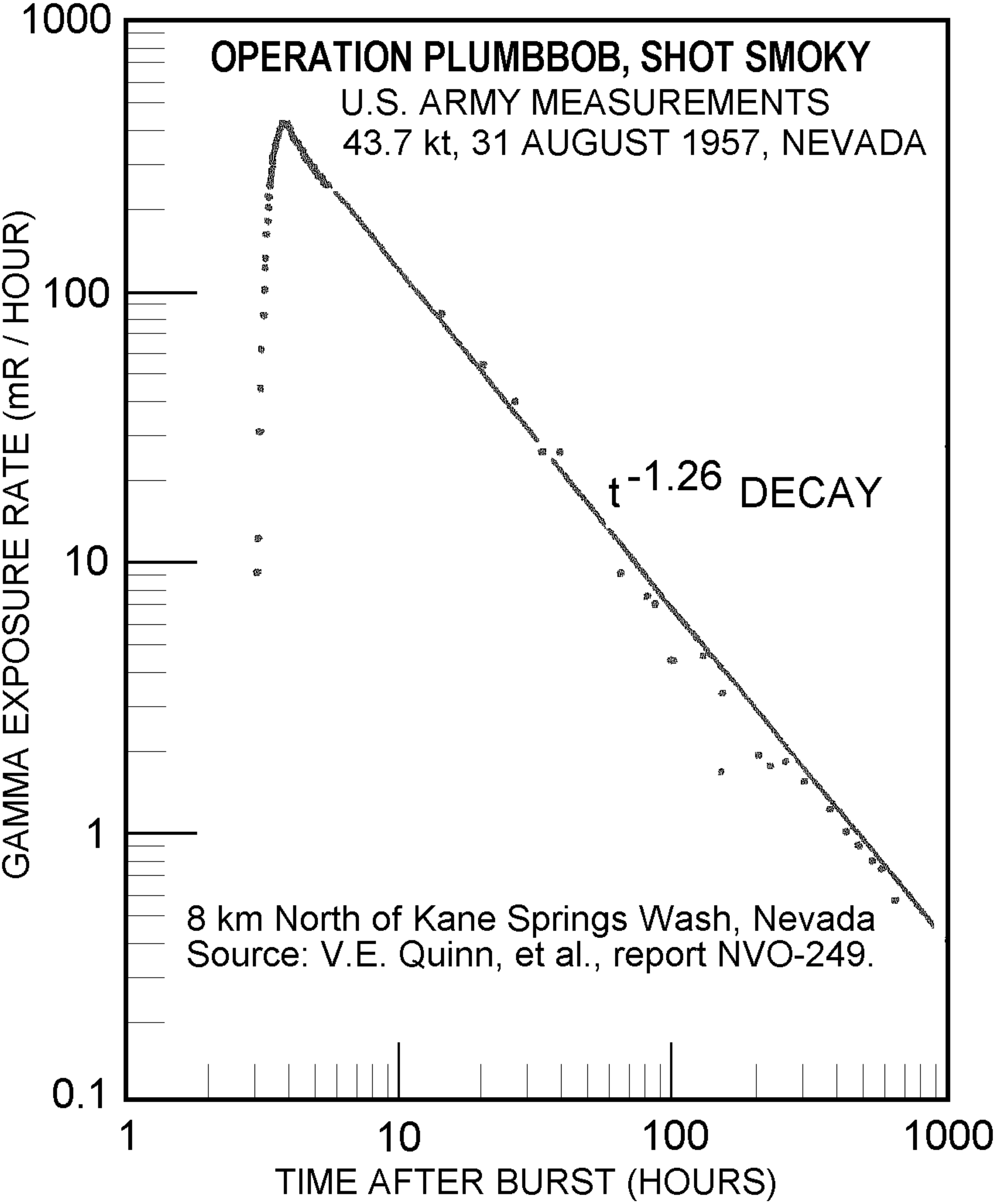


OPERATION CASTLE, 1954
100
10
1
0.1
0.01
RELATIVE GAMMA DECAY RATES
KOON, 0.11 Mt
BRAVO, 14.8 Mt
UNION, 6.9 Mt
ROMEO, 11 Mt
Source: Roy D. Maxwell, et al., AFSWP-978 (1955), p. 45
Secret - Restricted Data
0.1
1
10
100
1000
TIME AFTER BURST (DAYS)


OPERATION CASTLE, SHOT BRAVO, 1 MARCH 1954
14.8 Mt
STORM
OPERATION REDWING (FALLOUT FROM SHOT ZUNI)
OPERATION HARDTACK (FINAL BIKINI ATOLL TESTS)
Source: Edward E. Held, UWFL-91 (1965)
p. 9: "the reduction of gamma dose rates to ... half the predicted levels in 1959-63 probably reflects the downward movement ... in the soil."
RONGELAP ISLAND, RONGELAP ATOLL
YEARS
- NATURAL BACKGROUND RADIATION -
1 2 3 4 5 7 9
GAMMA EXPOSURE RATE (MILLIROENTGENS PER HOUR)
1000
100
10
1
0.1
0.01
1
10
100
1000
10,000
TIME AFTER BURST (DAYS)



OPERATION REDWING, BIKINI, 1956
Source: F.D. Jennings, Operation Redwing, Project 2.62a, report WT-1316.
Secret - Restricted Data.
RELATIVE GAMMA EXPOSURE DECAY RATES
TIME AFTER BURST (HOURS)
100
10
1
10
20
50
100
200
ZUNI
15% FISSION
NAVAJO
5% FISSION
TEWA
87% FISSION
FLATHEAD
73% FISSION
SHOT
TOTAL YIELD
ZUNI
3.53 Mt
NAVAJO
4.5 Mt
TEWA
5.01 Mt
FLATHEAD
0.365 Mt



OPERATION PLUMBBOB, SHOT SMOKY
U.S. ARMY MEASUREMENTS
43.7 kt, 31 AUGUST 1957, NEVADA
$t^{-1.26}$ DECAY
8 km North of Kane Springs Wash, Nevada
Source: V.E. Quinn, et al., report NVO-249.
GAMMA EXPOSURE RATE (mR / HOUR)
TIME AFTER BURST (HOURS)
1000
100
10
1
0.1
1
10
100
1000

CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

CIA 12 March 1962

12 MAR 1962

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT: "Some Factors Affecting the Planning of a Modern Offensive Operation", by Colonel-General Ye. Ivanov

1. Enclosed is a verbatim translation of an article which appeared in the TOP SECRET Special Collection of Articles of the Journal "Military Thought" ("Voyennaya Mysl") published by the Ministry of Defense, USSR, and distributed down to the level of Army Commander.

2. In the interests of protecting our source, this material should be handled on a need-to-know basis within your office. Requests for extra copies of this report or for utilization of any part of this document in any other form should be addressed to the originating office.

Richard Helms

Richard Helms
Deputy Director (Plans)

Following is a verbatim translation of an article titled "Some Factors Affecting the Planning of a Modern Offensive Operation", written by Colonel-General Ye. Ivanov.

This article appeared in the 1960 Second Issue of a special version of Voyennaya Mysl (Military Thought) which is classified TOP SECRET by the Soviets and is issued irregularly.

* * *

Weakening the nuclear strength of an opposing grouping of the enemy and depriving him of his capability to use nuclear weapons is one of the most important tasks, whose correct solution ensures the success of the offensive operation as a whole.

* * *

The mass utilization of nuclear weapons in short periods of time is the only way to achieve decisive destruction of the fire power of an opposing enemy grouping, destruction of his main nuclear/missile and aviation means, and also disruption of the control of troops and the disorganization of work of the rear services.

S E C R E T

Extracts from Khrushchev's letter to Kennedy, 26 October 1962 (Catalogue ref: PREM 11/3691)

QUOTE

Dear Mr. President:

I have received your letter of October 25. From your letter, I got the feeling that you have some understanding of the situation which has developed and (some) sense of responsibility. I value this.

Now we have already publicly exchanged our evaluations of the events around Cuba and each of us has set forth his explanation and his understanding of these events. Consequently, I would judge that, apparently, a continuation of an exchange of opinions at such a distance, even in the form of secret letters, will hardly add anything to that which one side has already said to the other.

I think you will understand me correctly if you are really concerned about the welfare of the world. Everyone needs peace: Both capitalists, if they have not lost their reason, and still more, Communists, people who know how to value not only their own lives but, more than anything, the lives of the people. We, Communists, are against all wars between states in general and have been defending the cause of peace since we came into the world. We have always regarded war as a calamity, and not as a game nor as a means for the attainment of definite goals, nor, all the more, as a goal in itself. Our goals are clear, and the means to attain them is labor. War is our enemy and a calamity for all the peoples.

It is thus that we, Soviet people, and, together with us, other peoples as well, understand the questions of war and peace. I can, in any case, firmly say this for the peoples of the Socialist countries, as well as for all progressive people who want peace, happiness, and friendship among peoples.

I see, Mr. President, that you too are not devoid of a sense of anxiety for the fate of the world, of understanding, and of what war entails. What would a war give you? You are threatening us with war. But you well know that the very least which you would receive in reply would be that you would experience the same consequences as those which you sent us. And that must be clear to us, people invested with authority, trust, and responsibility. We must not succumb to intoxication and petty passions, regardless of whether elections are impending in this or that country, or not impending. These are all transient things, but if indeed war should break out, then it would not be in our power to stop it, for such is the logic of war. I have

participated in two wars and know that war ends when it has rolled through cities and villages, everywhere sowing death and destruction.

In the name of the Soviet Government and the Soviet people, I assure you that your conclusions regarding offensive weapons on Cuba are groundless. It is apparent from what you have written me that our conceptions are different on this score, or rather, we have different estimates of these or those military means. Indeed, in reality, the same forms of weapons can have different interpretations.

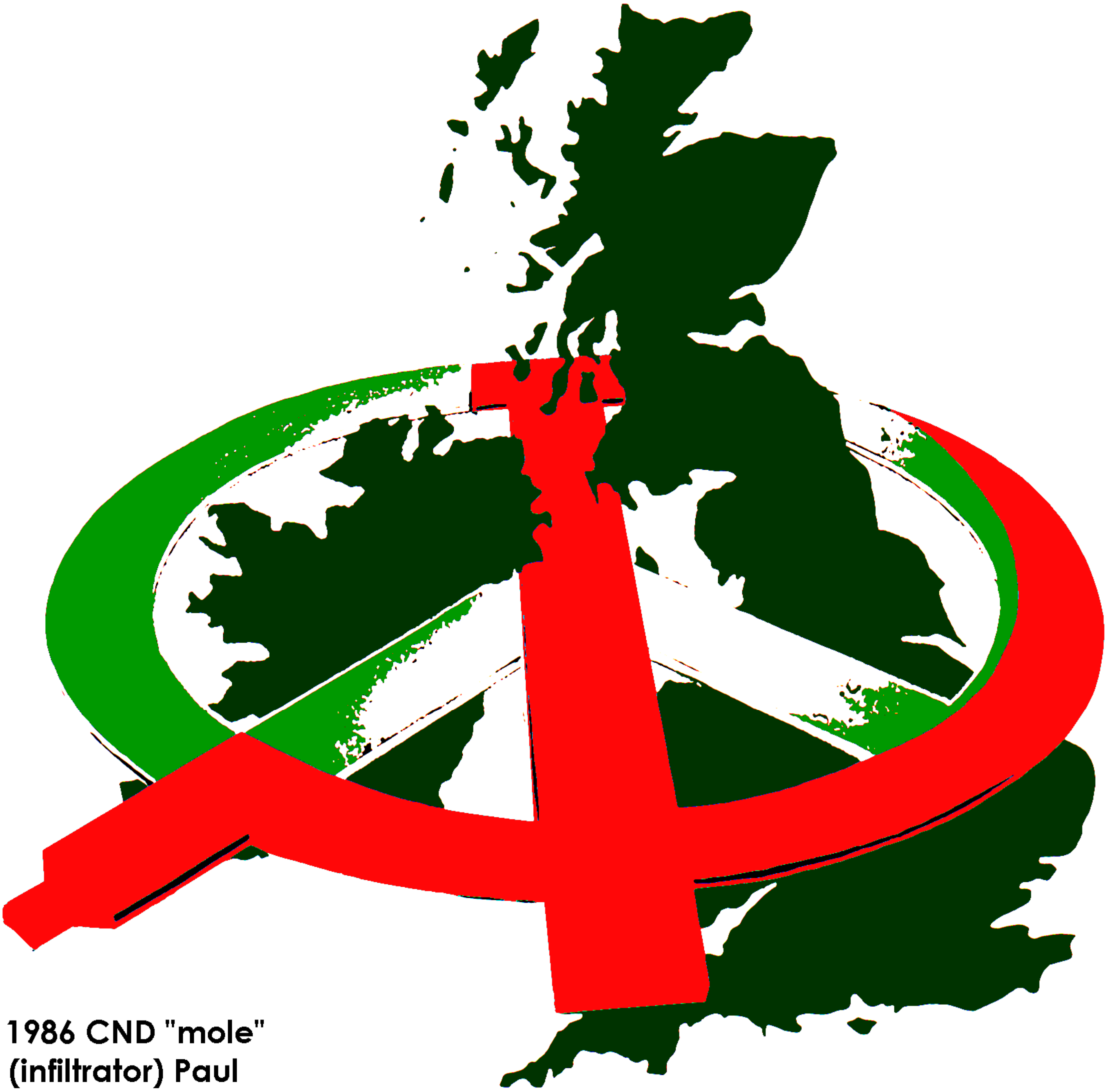
You are a military man and, I hope, will understand me. Let us take for example a simple cannon. What sort of means is this: offensive or defensive? A cannon is a defensive means if it is set up to defend boundaries or a fortified area. But if one concentrates artillery, and adds to it the necessary number of troops. Then the same cannons do become an offensive means, because they prepare and clear the way for infantry to attack. The same happens with missile - nuclear weapons as well, with any type of this weapon.

You are mistaken if you think that any of our means on Cuba are offensive. However, let us not quarrel now. It is apparent that I will not be able to convince you of this. But I say to you: You, Mr. President, are a military man and should understand: Can one attack, if one has on one's territory even an enormous quantity of missiles of various effective radiuses and various power, but using only these means? These missiles are a means of extermination and destruction. But one cannot attack with these missiles, even nuclear missiles of a power of 100 megatons because only people, troops, can attack. Without people, any means however powerful cannot be offensive.

Armaments bring only disasters. When one accumulates them, this damages the economy, and if one puts them to use, then they destroy people on both sides. Consequently, only a madman can believe that armaments are the principal means in the life of society. No, they are an enforced loss of human energy, and what is more are for the destruction of man himself. If people do not show wisdom, then in the final analysis they will come to a clash, like blind moles, and then reciprocal extermination will begin.

Let us therefore show statesmanlike wisdom. I propose: We, for our part, will declare that our ships, bound for Cuba, will not carry any kind of armaments. You would declare that the United States will not invade Cuba with its forces and will not support any sort of forces which might intend to carry out an invasion of Cuba. Then the necessity for the presence of our military specialists in Cuba would disappear.

'PEACE' OF THE DEAD



1986 CND "mole"
(infiltrator) Paul
Mercer exposed
USSR propaganda

Paul Mercer

Foreword by Lord Chalfont, OBE, MC, PC

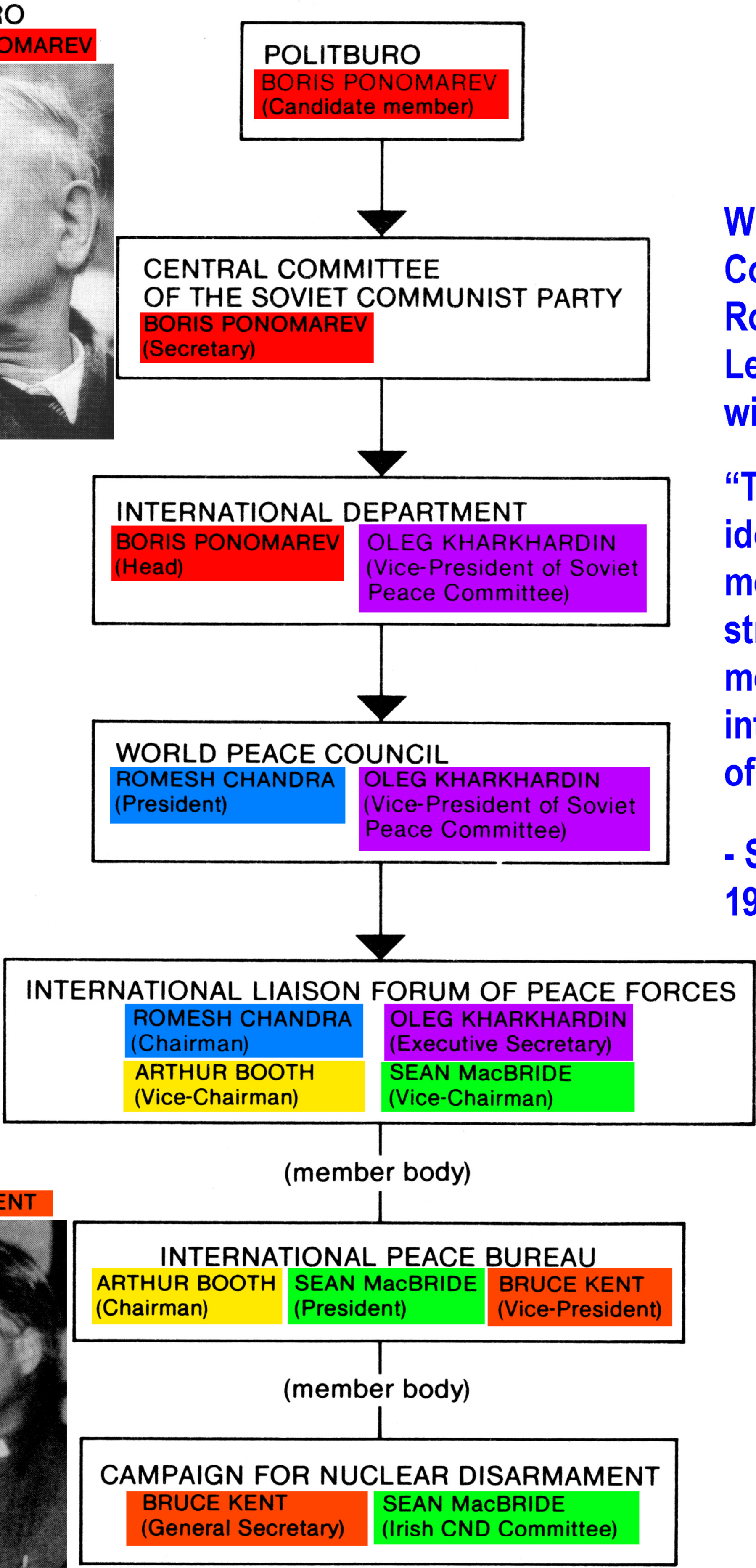
"I personally need no lessons on how to combat 'anti-Sovietism' in the peace movement from armchair peace campaigners. The consistent stand of CND for unilateral nuclear disarmament and withdrawal from NATO has been won by working as Communists in a principled non-sectarian way."—CND Vice-President, John Cox *Morning Star*, 8 January 1985

Paul Mercer, who graduated from Nottingham University in 1982, is a political research consultant and author of several specialist books on military aviation.

The author (*left*) with one of his 'sources', Mgr Bruce Kent—former General Secretary of the Campaign for Nuclear Disarmament.

"I don't condemn the IRA bombings in public—I explain that they are a direct response to British policy—in some situations it's not useful to preach pacifism."—CND Council Member, Pat Arrowsmith *Socialist Challenge*, 4 June 1982

POLITBURO
BORIS PONOMAREV

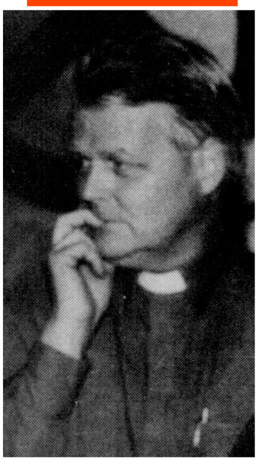


World Peace Council President Romesh Chandra, Lenin Peace Prize winner:

"There is a wrong idea that détente means lessening the struggle ... détente means the intensification of the struggle ..."

- Sunday Chronicle, 19 December 1976

CND
BRUCE KENT



One of the CND's many links with the World Peace Council in 1983

Sean MacBride is a former IRA Commander awarded a Lenin Peace Prize and a Nobel

Boris Ponomarev, Politburo

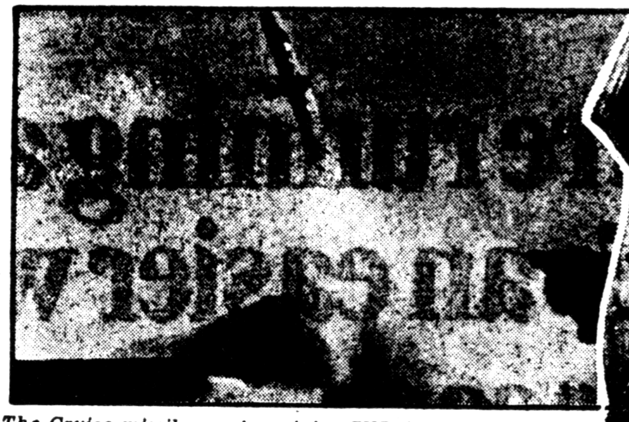
(b 1905, Red Army 1919, Central C. 1956, Politburo 1972)

Head of the International Department, CCCP

Propagandarist inventor of détente appeasement

Boris Ponomarev was author of the books "The Great Vital Force of Leninism" and "The Liberation Movement", both Russian propaganda publications sent directly by the International Department of the Politburo to the British National Union of Teachers (NUT) as direct infiltration of Britain's schools. (Sources: John Izbicki, Daily Telegraph, 18 May 1981; Pincher, "The Secret Offensive") Result: NUT's "Teachers for Peace" anti-nuclear lobby for pro-détente school fiction, like "Z for Zachariah".

HOW MOTHERS LIKE ME ARE DRIVEN TO JOIN THE BIG PEACE DEMOS



The Cruise missile . . . target for CND fairytales. And (right) a concerned mother on the march.

This CND blackmail at our school gates . . .

by ANN LESLIE

SO were you there on October 22 ? Were you one of the huge crowd of 250,000 demonstrators thronging Hyde Park ?

And if you were not there, did you feel a little bit guilty about it ? Did some of that magnificent pre-rally CND propaganda get to you ?

Because it was indeed powerful. propaganda. On Friday morning, the day before the demos, I and other mothers were delivering our tiny sons and daughters to their North London primary school.

This humdrum, happy, chattering little scene in the sunshine was briefly overshadowed by a sudden glimpse of apocalyptic terror in the form of two leaflets handed out to us at the gates.

Horrors

The first said : 'October 22. Where will you be ?' The second, from the Camden Labour Party, told us why we should be there on Saturday. Cruise missiles, due to be installed in December, will 'make nuclear war more likely. . . .'

And just in case we mothers were to preoccupied juggling with push-chairs and shopping-bags to understand the implications of that, the leaflets told us what would happen if a one megaton bomb was exploded over Trafalgar Square.

We live in the 'area north of London Zoo up to Hampstead Heath' and that would mean, among other horrors, '50 per cent. dead from blast (ruptured guts, crushed bones).'

It didn't of course mention that the Soviets already have over 350 SS20s installed, each with three warheads, two-thirds of which are targeted on Western Europe. Information like that might 'confuse' us mothers outside the school gates.

Nor did it mention that most members of unofficial peace groups in Eastern Europe — those not controlled for propaganda purposes by the Soviet authorities — are bitterly opposed to the unilateralist and neutralist ideas of CND.

These Eastern Europeans know the realities of Soviet power, and they know that the West can only hope to succeed in disarmament negotiations if it negotiates from a position of strength.

The message handed out at the school gates had to be kept 'unconfused' by such 'irrelevant' facts.

And so, yes, those leaflets did have a powerful emotional kick. As I watched my adored little five-year-old cheerfully hurrying into class with her best friend, I felt a sudden lurch in my stomach.

Those two merry little souls, millions of innocents like them — 'ruptured guts, crushed bones'. Please God, no !

Declined

So why didn't I join that march on Saturday ? Don't I care ?

Well, it so happens that I was there—not as a demonstrator but as an observer. I was making a film report for Channel 4 on the demonstration which CND now claims is 'proof' that the peace movement has not lost its battle.

I had assumed that everyone in that crowd on Saturday actually knew what they were demonstrating about. But did they ?

Oh sure, they were, as everyone told me earnestly, demonstrating 'in favour of peace and against nuclear war'. Well, you'd have to be criminally insane not to be in favour of peace and against nuclear war. So let's try to take it beyond the infants' class level.

No use pointing out that public opinion as expressed by the people of Hungary, East Germany, Czechoslovakia, Poland and Afghanistan has only influenced the Kremlin into greater spasms of repression and cruelty.

Destroy

Presumably most of those at the demonstration were convinced by CND's propaganda

Nor is there any illusion at NATO or SHAPE headquarters (where last week I sat through many discussions with men with titles like Head of Nuclear Planning) that America could fight a limited nuclear war in Europe.

As General Rogers, the American Supreme Allied Commander, Europe, said : 'The Soviets have said that any American weapon system being fired at Soviet soil will be cause for her to attack the United States with strategic weapons.'

How many of the people in that crowd of 250,000 have been told any of this by CND ? Very few.

Alas, some of them didn't even seem to know the difference between 'unilateralist' and 'multilateralist'. One nice, earnest young man told me he was there because he was a 'multilateralist'.

Outbreak

But this, I pointed out, was a demonstration in favour of 'unilateralism'. His response was a look of utter bafflement.

Many in the crowd used the demonstration to promote a whole variety of separate causes. Like the seller of the Hard-Left newspaper who told me we must 'defend the Soviet Union against Western imperialism.'

Like those who wanted solar heating in homes. Like the Hare Krishna people who said that meat-eating was the cause of nuclear war.

And like the Greenham women, who were collecting money to finance a 'permanent' peace headquarters.

Not so long ago, they were telling me that the arrival of the first Cruise missile would mean the outbreak of nuclear Armageddon. Since the end of the world is nigh in a few weeks, it seemed odd, to say the least, to ask for money to set up a 'permanent' headquarters.

So all of you who might have felt a twinge of guilt about not 'being there on October 22' — forget it. The majority of those who were there were well-meaning, hopelessly muddled, easily exploited people

1983
Daily Mail

This battle for your child's mind

The fact is that most parents, throughout the country, would be horrified if they realised how, even in the basic routine subjects, such as English, History and Science, their sons and daughters are being indoctrinated.

Take a look at the methods employed in sample lessons in at least one school:

An English lesson is based on how the language of the nuclear age is used by the media to condition ordinary people into accepting Cruise missiles.

Then the teacher takes a headline from the sports pages: 'Hammers massacre Coventry in five-goal blitz.' He uses it as the starting point for a discussion which moves on to deplore the way newspapers and TV glory in war and distort the views of those who believe in peace.

Science, before lunch, is easier. The Physics master, in defiance of a request from the Minister of Education, gives the pupils the full benefit of his personal conviction that American possession of a nuclear arsenal is a one-way suicide trip for mankind.

History, in the afternoon, is a study, through books supplied to the school by Novosti, the Soviet Press agency, of Russia's peaceloving intentions over the last 30 years, compared with Western war-mongering.

A fantasy? Not the sort of school you would dream of letting your child attend?

No. It is fact. And you might soon have no choice but to send your child to such a school.

For there is at least one comprehensive school in Britain where each one of those sample lessons—or ones similar—has already taken place. And there are at least a dozen major local

by Rodney Tyler

In Britain's biggest teachers' union, the National Union of Teachers, more than 10 per cent. of delegates at the annual conferences come from just one of the extreme Left-Wing groups operating within the educational system.

But what he feared most of all was the attempt by the notorious Inner London Education Authority to foist on him those that were politically in line with its far-left leadership.

This school year he will be ordered to give more status to

released for special courses in how to combat racism.

Another London head described a visit from one of the proliferating 'advisers' who demanded to know why Irish politics, history, literature, and music were not being taught to the Irish children in his school.

The visitor accused him of 'not co-operating' when he pointed out that he had 30 different nationalities in the school and if he discriminated in favour of one minority he would have to favour them all.

But he sees as far more sinister the question he and ILEA's 170 comprehensive heads were forced to answer recently: 'Do you recognise the role of the "hidden Curriculum" in political education?'

He told me: 'It was rather like being asked if I had stopped beating my wife. If I said yes it would have meant that I was secretly indoctrinating my children, if I said no it meant I was refusing to do so. Either way I would be open to attack.'

The hidden curriculum is another way, in Left-Wing eyes, of influencing children. Put bluntly, it means taking every opportunity as it arises in normal lessons to put across your political message.

It is this sinister move, which ILEA—Britain's biggest authority—is poised to introduce. Thus, both overtly and covertly they plan a massive programme of indoctrination.

Printed advice on how to get rid of uncooperative heads which circulates secretly among some of these groups includes such gems as:

- Hold sudden meetings at the most difficult times for the head and his staff.
- Prolong meetings unnecessarily and harass officials of the Board into resignation — then put your own people into their positions

CND: IS IT ALL A RUSSIAN CON TRICK?

Moscow's making fools of our ban the bomb brigade

By MARJORY DAVIDSON

THE 19 Very Important Visitors were welcomed to Moscow in the style of Heads of State.

Police escorted their motorcade as it swept through red lights on the way from Sheremitovo Airport to a downtown hotel.

Visits to the Bolshoi Ballet, the old Czarist capital, Leningrad and the fabled cities of Tashkent and Samarkand were on the programme.

And it was red carpet treatment all the way.

The cost of this 10 day jaunt? Nothing—save the £190 cut-price air fare from London.

Who were the lucky 19? Not pop stars, or soccer players or even astronauts.

They were members of the Campaign for Nuclear Disarmament and fellow sympathisers. Lord Brockway, co-chairman of the World Disarmament Campaign, led the party which included respected pacifists Dr Malcolm Dando, of Bradford University's School of Peace Studies, Richard Keeble, editor of The Teacher, and Father Owen Hardwicke, of Pax Christi, the Roman Catholic Disarmament lobby.

They had come to Moscow to talk peace.

But like the hundreds of thousands of ban-the-bomb marchers throughout Europe, they were and are, tragically, just dupes.

They are part of a campaign that is orchestrated and financed by the Soviet Union with the direct purpose of weakening the West, her resolve and her strength, while Russia continues to build up the most fearsome military machine in history.

Take that starry-eyed journey last March. The Russians quickly showed their visitors that they wanted others to talk about peace. They want others to disarm.

The naive band of travellers were campaigning for Britain to scrap all nuclear weapons. When they hesitantly asked the Kremlin to make a possible ten per cent reduction in its nuclear arsenal, the reply was a brutal "Niet."

In Britain, the ban-the-bomb campaign is booming. Membership has increased from 3,000 to 37,000 in 18 months and includes many idealistic young people.

Last October, more than 150,000 people from all over Britain attended the biggest demonstration in London since the heady days of the Sixties.

Brezhnev flew from Moscow to meet the 1,000 Soviet-subsidised delegates in Sofia.

Labour MPs present included Roy Hughes (Newport), James Lamond (Oldham East), Andrew Bennett (Stockport North), William Wilson (Coventry SE) and Alf Lomas (Euro MP London NE).

Alex Kitson, executive officer of the Transport and General Workers' Union, was also among the guests.

In Britain, as CND membership has grown, a Left-wing takeover has emer[illegible] the top.

Idealists have been replaced by militants with potent Euro-Communist connections.

They seek a power base in Britain. They aim to get it by exploiting the fear and horror felt by decent men and women at the idea of nuclear war.

They have formed special sections — Youth CND and Christian CND —to extend their sphere of influence.

They are especially active in trying to persuade trade unions to affiliate to CND.

These are the facts to remember when next you are impressed [illegible] lowers on the march— Moscow-style.

LEFTIES WHO RUN PEACE CAMPAIGN

September 30, 1938 peace promise:

We, the German Führer and Chancellor and the British Prime Minister, have had a further meeting today and are agreed in recognising that the question of Anglo-German relations is of the first importance for the two countries and for Europe.

We regard the agreement signed last night and the Anglo-German Naval Agreement as symbolic of the desire of our two peoples never to go to war with one another again.

We are resolved that the method of consultation shall be the method adopted to deal with any other questions that may concern our two countries, and we are determined to continue our efforts to remove possible sources of difference and thus to contribute to assure the peace of Europe.

A Hitler

Neville Chamberlain

September 30. 1938.

$5.95

AMERICA IS IN DANGER

by General Curtis E. LeMay

"America is in danger. . . . We find ourselves in a purely defensive role, unable to make our will felt even in a conflict with a backward jungle country. . . . Our strategic nuclear superiority has given us much diplomatic strength in the past. Do we still have that strength? Do we have enough faith in our general war capability to prevail in a crisis? I think not. That is why America is in grave danger."

In this book Gen. Curtis E. LeMay—former member of the Joint Chiefs and first commander of the Strategic Air Command—closely analyzes and challenges the government's claim to have greatly strengthened our military position. He finds minor improvements in conventional forces, but actual reductions in nuclear capability and an over-all decline compared to Soviet forces.

General LeMay, while stressing the paramount need for civil control of the military, attacks civilian manipulation of technical military decisions as unprecedented and disastrous.

(continued on back flap)

(continued from front flap)

Assessing the strategic situation, General LeMay argues that our former policy of overwhelming nuclear superiority proved itself during the crises in Berlin, Taiwan, and Cuba, and produced twenty years of relative peace. Yet the current Administration has opted for a new and untested posture that permits, even encourages parity with Russia.

According to the author, we have fostered disunity in NATO—first, by failing to sign a German peace treaty (General LeMay proposes what he believes to be a workable solution), and second, by our nonproliferation policy, which, combined with complete dependence on massive retaliation for deterrence, has caused European leaders to question our nuclear guarantees.

While approving the decision to produce a thin-line antiballistic missile defense, General LeMay pleads for an urgent upgrading of this program, pointing to Russia's rapidly growing ABM force.

Finally, General LeMay analyzes our limited war strategy with particular reference to Vietnam and proposes immediate steps to insure not simply a military victory but a stable political and social solution.

As a man who has devoted his life to America's security, the author strongly believes that present defense policies endanger our ability to survive. In this urgent and thoughtful book General LeMay not only criticizes; he offers alternate solutions to bolster our strength and preserve peace.

FUNK & WAGNALLS
NEW YORK

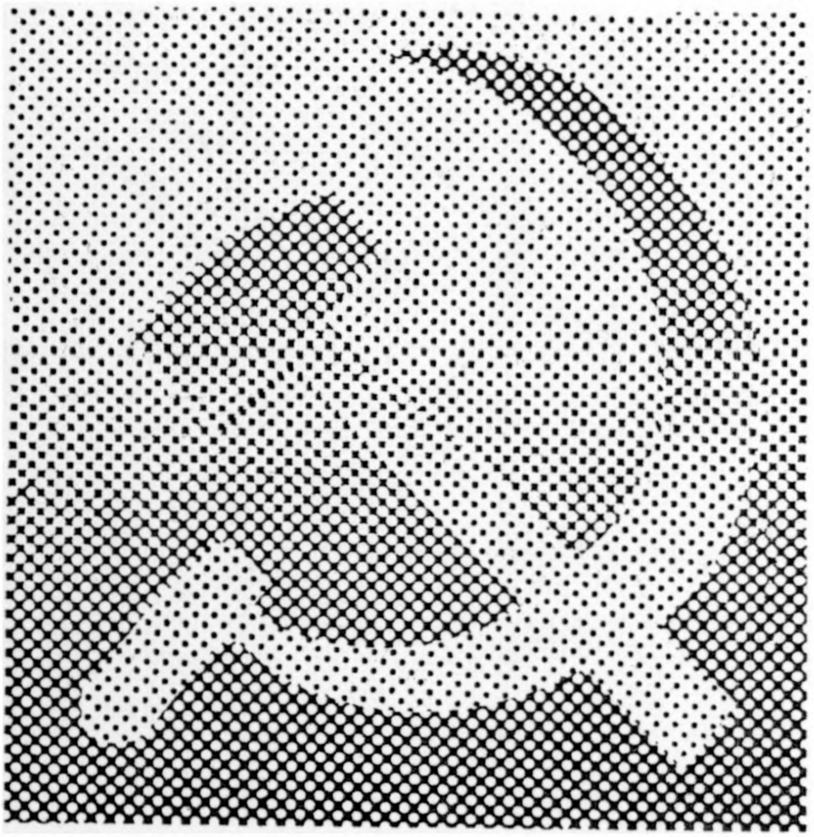
Jacket design: Paul Bacon Studio

Spencer Weart, Never at War: Why Democracies Will Not Fight One Another, Yale University Press, 1998:

"This idea had been developed by 1785 ... A world where every state was a democracy, [Immanuel Kant] wrote, would be a world of perpetual peace. Free peoples ... will make war only when driven to it by tyrants. ... there have been no wars between well-established democracies. ... the absence of wars between well-established democracies [has a probability of being coincidence] less than one chance in a thousand. ... robust statistics ... When toleration of dissent has persisted for three years ... a new republic [is] 'well established.' ... [Diplomatic pacifism made war by the 'appeasement trap' of trying to 'accommodate a tyrant.'] ... the tyrant concluded that he could safely make an aggressive response ... [thus] negotiating styles are not based strictly on sound reasoning."

Military Psychology

A Soviet View



Edited by:
V.V. SHELYAG
A.D. GLOTOCHKIN
K.K. PLATONOV

Moscow 1972

TRANSLATED AND PUBLISHED
UNDER THE AUSPICES OF
THE UNITED STATES AIR FORCE

ВОЕННАЯ ПСИХОЛОГИЯ

**УЧЕБНИК
ДЛЯ ВЫСШИХ ВОЕННО-ПОЛИТИЧЕСКИХ
УЧИЛИЩ
СОВЕТСКОЙ АРМИИ
И ВОЕННО-МОРСКОГО ФЛОТА**

Под редакцией
В. В. ШЕЛЯГА,
А. Д. ГЛОТОЧКИНА,
К. К. ПЛАТОНОВА

Ордена Трудового Красного Знамени
ВОЕННОЕ ИЗДАТЕЛЬСТВО
МИНИСТЕРСТВА ОБОРОНЫ СССР
МОСКВА—1972

Chapter 28. The Psychology of Agitation and Propaganda Activity

"Propaganda" and "agitation" are words of Latin origin. To propagandize means to disseminate knowledge, ideas, views, and theories, while to agitate means to stir up definite aspirations and arouse people to action.

However, the essence of our Party and Leninist propaganda is significantly deeper. It must not only disseminate and transmit revolutionary ideas, but also make them the convictions of the people. By agitation, we mean a direct appeal and ability to direct the energy and will of the people to struggle for carrying out the ideas of communism in practice.

A scientific explanation of the essence of communist propaganda and agitation as well as their unity and differences was provided by V. I. Lenin.

V. I. Lenin in his work *Chto Delat'?* (What Is to be Done?), from the example of explaining the question of unemployment to the masses, showed the difference between propaganda and agitation: ". . . The propagandist, if he takes, for example, the same question of unemployment, should explain the capitalist nature of the crises, show the cause of their inevitability in modern society, sketch the necessity of transforming it into a socialist society, and so forth. In a word, he should provide 'many ideas,' or so many ideas that all these ideas at once, in their aggregate, will be assimilated by only a few (comparatively) persons. But an agitator, in speaking on the same question, takes the most outstanding example or one which is best known to his listeners . . ."

"The art of any propagandist or agitator," stressed V. I. Lenin, "is in influencing a given audience in the best way, and making a certain truth for the audience as convincing as possible, as easy to assimilate as possible, and as visibly and strongly memorable as possible." V. I. Lenin, *Poln. sobr. soch.*, Vol 21, p 21.

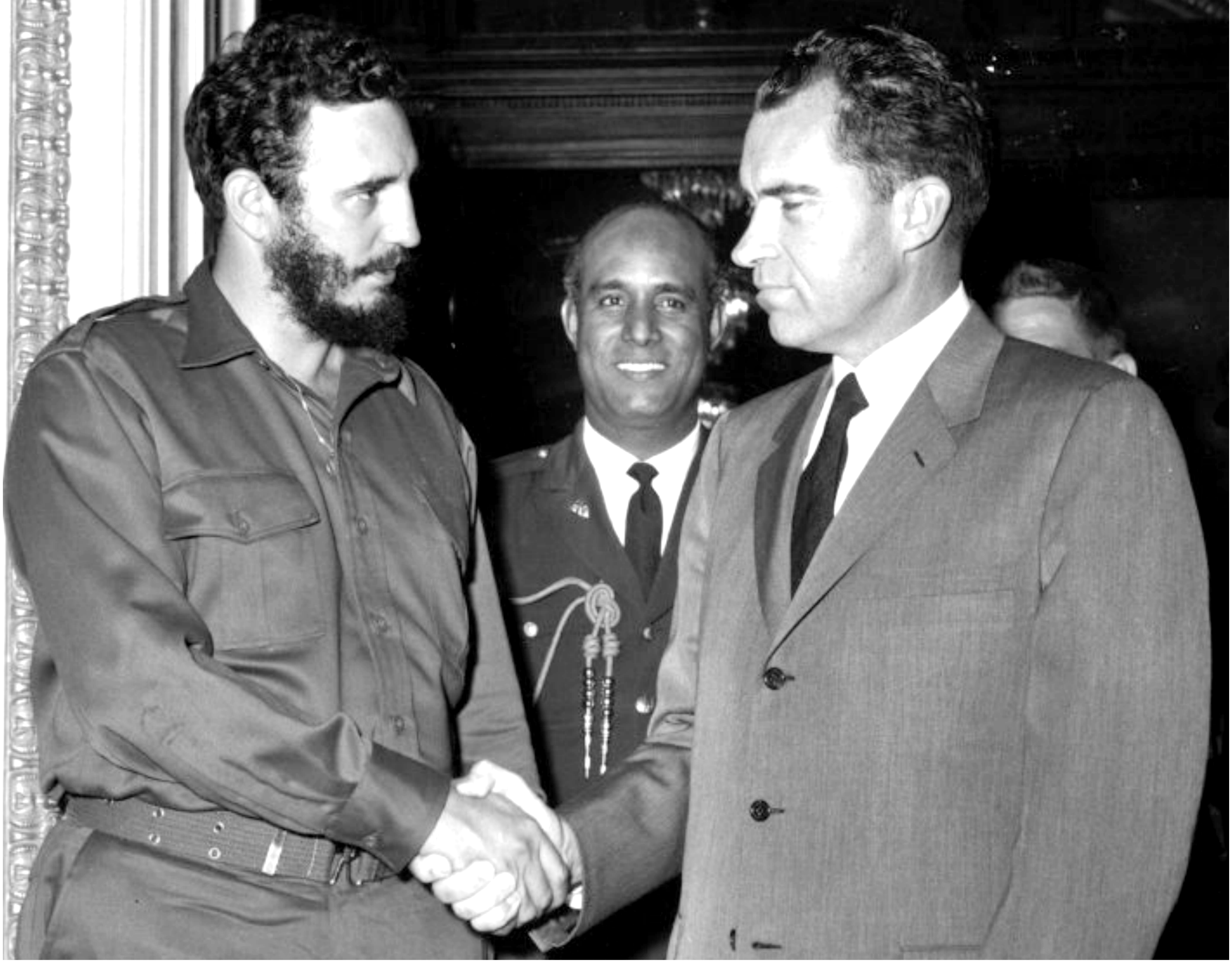
Convincingness is achieved by the propagandist's profound knowledge of theoretical problems and practical questions which he explains. A propagandist's speech is notable in its vivid exposition of the basic thought and main idea, reinforced with rich factual material, and enrichment of the listeners with new knowledge.

In propaganda, it is advisable to limit oneself in using obvious and reliable judgments, for an abundance of them frees the listener from the need to think, and teaches dogmatism.

Fourth, the words of an agitator will be convincing if and when these words are theoretically argued with sufficient profundity. The talk of an agitator is not only a conversation on current subjects, but also an explanation of a certain idea or theory. Only profound understanding of this idea by the masses will raise their revolutionary activeness which the agitator directs by his appeals in the appropriate manner. For this reason, a true agitator is a politically intelligent and ideologically convinced fighter for the Party. The best agitators are political workers, commanders, engineers, progressive-minded personnel, soldiers, and sergeants whose words are an authority for comrades.

Fifth, agitation cannot be effective if it is not capable of becoming a means for an emotional effect upon the listeners. The agitator influences the audience not only by his words, but by the entire range of his human personality, how he proves the theoretical theses, and by his tone and demeanor. The vivid and lively language of an agitator, and the most successful and intelligent form found by him for expressing an idea are important factors helping to carry out the agitation passionately and convincingly.

The observance of the listed conditions, which provide for the effectiveness of an agitator's talk, requires from him certain qualities, profound knowledge, high personal culture, combat and methodological preparation, ability to think logically, as well as the capability to come into contact with different people.



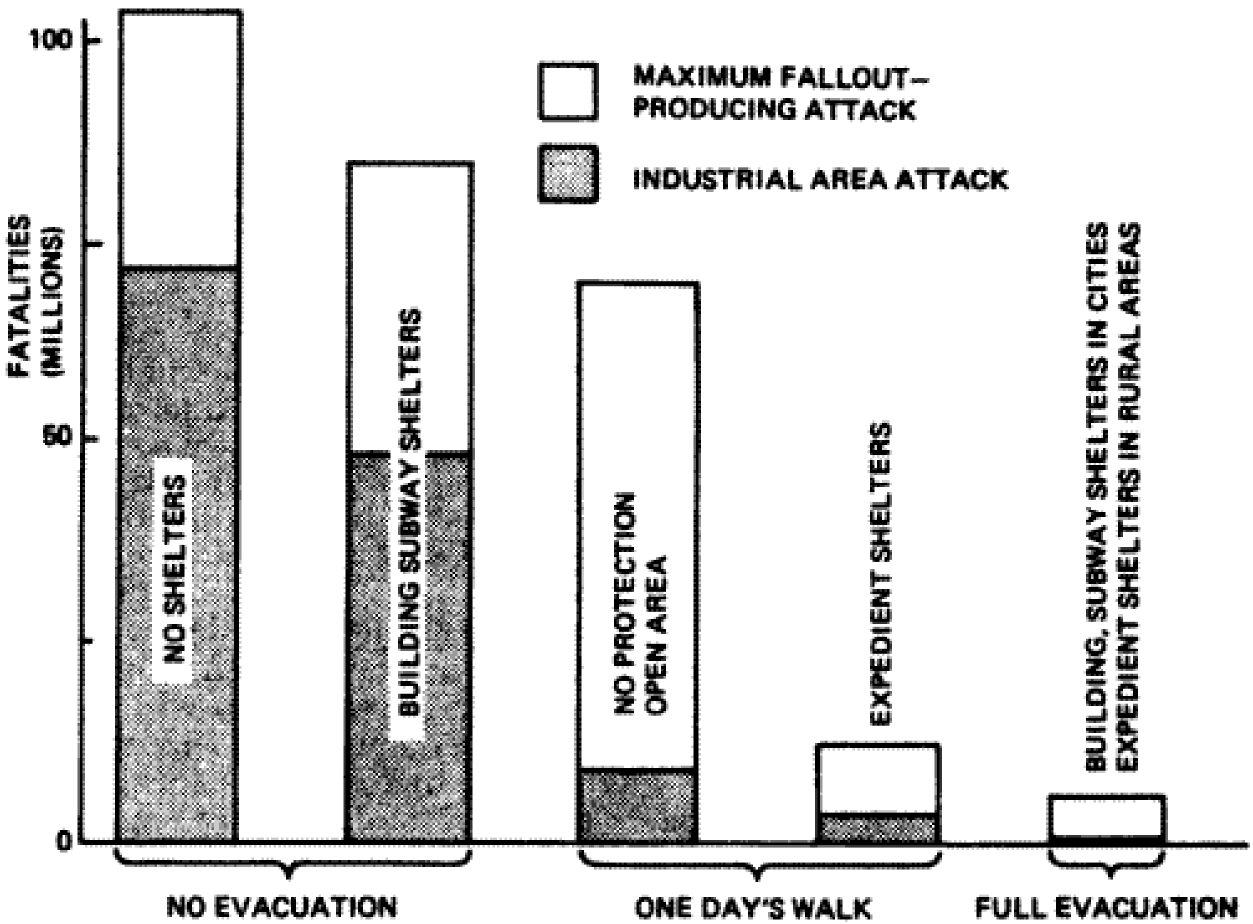
April 21, 1959 Cuban President Fidel Castro and Vice President Nixon

INDUSTRIAL PREPAREDNESS AND NUCLEAR WAR SURVIVAL

WEDNESDAY, NOVEMBER 17, 1976

U.S. CONGRESS,
JOINT COMMITTEE ON DEFENSE PRODUCTION,
Washington, D.C.

MR. THOMAS K. JONES



Soviet population fatalities (surviving U.S. Strategic Forces).

Robert Scheer

WITH ENOUGH SHOVELS: Reagan, Bush & Nuclear War

"Dig a hole, cover it with a couple of doors and then throw three feet of dirt on top... It's the dirt that does it... if there are enough shovels to go around, everybody's going to make it."

—T. K. Jones, Deputy Under Secretary of Defense for Strategic and Theater Nuclear Forces

"President Ronald Reagan had been in office less than a year when he approved a secret plan for the United States to prevail in a protracted nuclear war. This secret plan, outlined in a so-called National Security Decision Document, committed the United States for the first time to the idea that a global nuclear war can be won."

With these words Robert Scheer, the distinguished national reporter for the *Los Angeles Times*, begins this astonishing revelation of how a handful of Cold War ideologues—led by the President himself—have reversed the longstanding American assumption that nuclear war means mutual suicide.

Robert Scheer's aim in *With Enough Shovels* is to expose the deadly course on which we are now embarked, a course that categorically rejects the strategic assumptions that prevailed from Presidents Eisenhower through Carter and that sustained the Nixon-Kissinger program of détente—a program which our current leaders call "appeasement."

Leon Gouré

WAR SURVIVAL IN SOVIET STRATEGY

USSR CIVIL DEFENSE

With a Foreword by
AMBASSADOR FOY D. KOHLER

SECRET CIA report leaked to Reagan in 1979

integrated city and rural civil defense exercises. One exercise of this type occurred in 1975 at Lytkarino, a town of 40,000 people near Moscow and a probable relocation site for Muscovites. According to Soviet publications, thousands of people participated, communication and reconnaissance operations were conducted, and shelters were occupied by local workers. Another 1975 exercise, in Tul'skaya Oblast, involved the city of Kimovsk in Kimovskiy Rayon; this was known as an "integrated rayonal exercise." There may

LEON GOURÉ is a Professor of International Studies and Director of Soviet Studies at the Center for Advanced International Studies at the University of Miami. A graduate of New York University, Columbia University School of International Affairs and Russian Institute, and Georgetown University, he is the author of *Civil Defense in the Soviet Union*, *The Siege of Leningrad*, and *Soviet Civil Defense 1969-70*. He has also co-authored *Soviet Strategy for the Seventies: From Cold War to Peaceful Coexistence*, *The Role of Nuclear Forces in Current Soviet Strategy*, and *Soviet Penetration of Latin America* among others.

1st printing .... April 1976

2nd printing .... August 1976

Foreword

by Foy D. Kohler

Dr. Leon Gouré has devoted many years of study to Soviet civil defense and other war-survival policies and activities in the USSR. The area was one of his specialties while serving as a Senior Analyst for the RAND Corporation from 1951 to 1969, and he has continued his researches since joining the University of Miami in 1969 as Director of Soviet Studies and Professor in the Center for Advanced International Studies.

As a part of our work program for this larger undertaking, the Center has held a series of special conferences wherein we have subjected our methodology and research findings to critical review by outside experts, including authoritative academic and governmental specialists on Soviet affairs and high-ranking policy-action officers from Defense, State and other agencies directly concerned with U.S.-Soviet relations.

At two of these conferences, special attention has been given to the Soviet war-survival problem: One in June 1975 included an exploration of how war-survival capabilities fit into the Soviet appraisal of the present and future "correlation of world forces." The second, held in January 1976, included a thorough examination of the implications for U.S. security interests and U.S. policy choices of what Moscow is actually doing in the war-survival area.

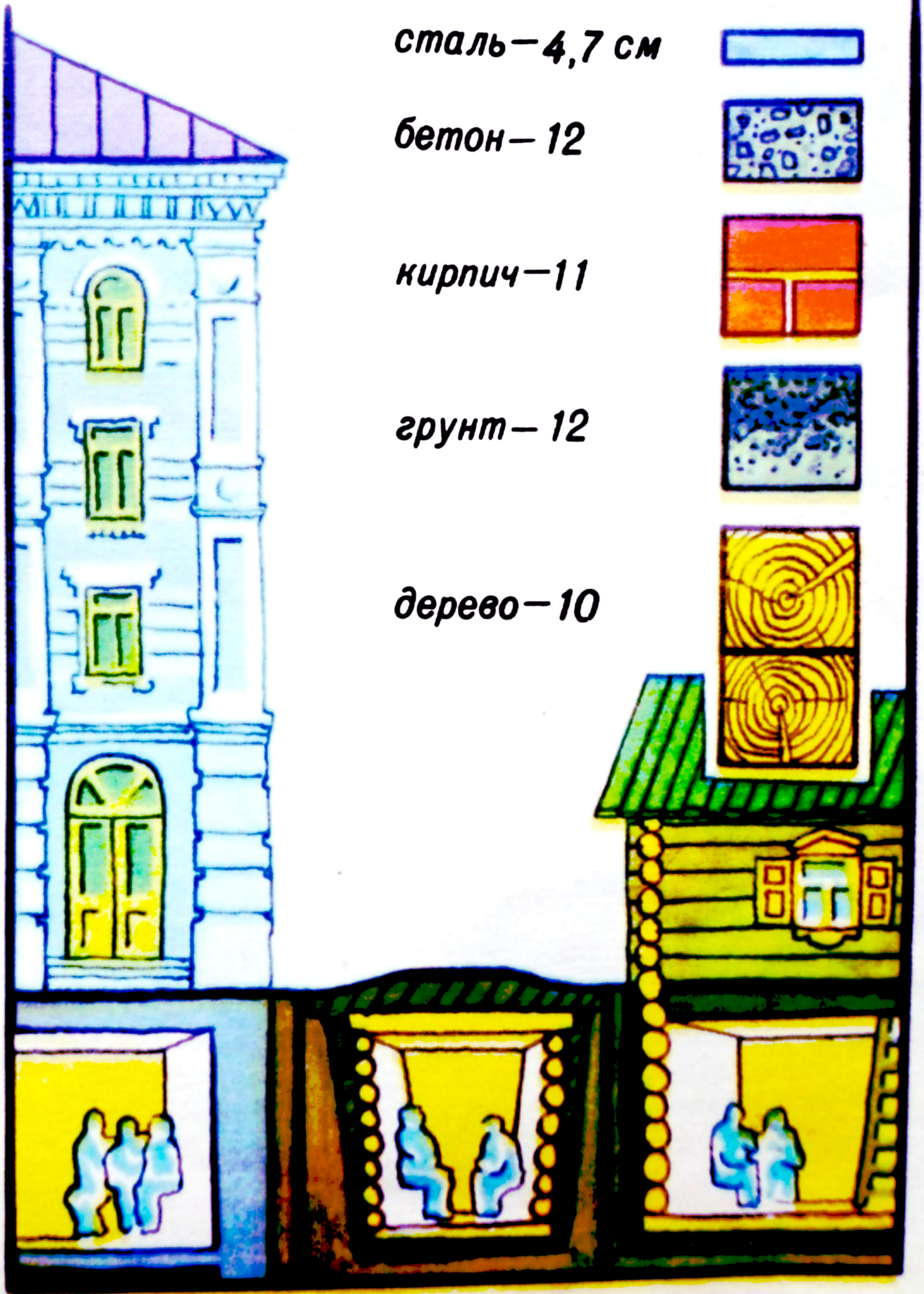
Nearly all of the experts at our conference viewed the reasoning behind the overkill concept as "absurd." One cited as an example an article in the April 6, 1975 *Bulletin of the Atomic Scientists* in which the author argued that with its present stockpile of nuclear weapons the U.S. could destroy the world's population "twelve times over." The author's calculation was arrived at by multiplying the casualties per kiloton in Hiroshima and Nagasaki by the total number of kilotons in the U.S. nuclear arsenal and then dividing by the number of people living in the world. Such a calculation was characterized as completely misleading. Leaving aside such questions as how many U.S. weapons would survive a Soviet attack on this country and how many of the residue could be delivered on target, "it implies that means can be devised to collect the entire target population into the same density as existed in Hiroshima and Nagasaki and keep them in a completely unwarned and hence vulnerable posture. A statement of identical validity is that the world's inventory of artillery shells, small arms ammunition, or for that matter, kitchen knives or rocks can kill the human population several times over."

It was recalled that more than 10 billion pounds of TNT was dropped on Germany, Japan and Italy during World War II. This equalled more than 50 pounds for every man, woman and child in the three countries. Arithmetically considered, the result should have been the total annihilation of one and all of these. During the Vietnam War, more than 25 billion pounds of TNT were dumped on North and South Vietnam (15 billion by air and some 10 billion by other means) for an average of some 730 pounds for each of a total population of 34 million and an average of 3,000 pounds for each person in prime target areas; yet the U.S. was unable to kill enough people or to disrupt economic life, transportation and communications sufficiently to even avoid a humilitating defeat in the war.

The basic issue, it was agreed, is how Moscow intends to exploit the situation politically. The Soviet risk calculations and ability to use its military power for political purposes are already being increasingly influenced by Moscow's perceptions of asymmetries between the U.S. and Soviet war-survival versus assured destruction capabilities. According to Moscow's view, these asymmetries are of great strategic significance for making Soviet power credible as a deterrent and as an instrument of policy. Soviet spokesmen have given clear indication of their awareness of the lack of a war-survival program in the U.S. as well as of the vulnerability of the U.S. arising from the high degree of concentration of its population and industry in a few areas of the country. It is inevitable, therefore, that the Soviet leadership will perceive this asymmetry between the Soviet Union and the U.S. as altering the balance of forces in Moscow's favor, and as affecting the credibility of the respective strategic deterrence and war-fighting postures of the two countries.

In effect, with its growing war-survival capability, the Soviet Union could well conclude that the U.S. threat of "massive retaliation" has no credibility except as an act of sheer desperation. In crisis situations, this factor could decisively influence both sides' risk calculations and consequently their relative ability and willingness to hold a hard line. The Soviet Union could confront the U.S. with its ability to keep Soviet population and resource losses within acceptable limits, all the more so if it carries out the evacuation of its cities, as against the certainty of U.S. losses of 50 percent or more of its population and of a very large portion of its industry. This would place the U.S. at a great disadvantage in the management of the crisis and in its negotiations with the Soviet Union. Instead of a "balance of terror" which equally restrains both sides, the "terror" would be mainly on the part of the U.S. and, faced with the possibility of national "suicide," the public reaction to it would be likely to deprive the President of any flexibility in his policy choices in dealing with Moscow.

Экспозиционную дозу радиации ослабляют вдвое материалы толщиной



Secret

Interagency Intelligence Memorandum

CIA HISTORICAL REVIEW PROGRAM
RELEASE AS SANITIZED

Soviet Civil Defense

~~Secret~~

NIO IIM 76-041
November 1976

Copy № 404

— *Basement*—shelters created by adapting the basement areas of residential, government, and industrial structures, primarily for protection against fallout. (See Figure 12.)

— *Subways*—shelters provided by using the subway tunnels in major Soviet cities. The degree of protection against blast varies within subways, but all afford good protection against fallout. (See Figure 13.)

— *Expedient or hasty*—shelters built with materials readily available during the period immediately prior to a nuclear attack. (See Figure 14.)

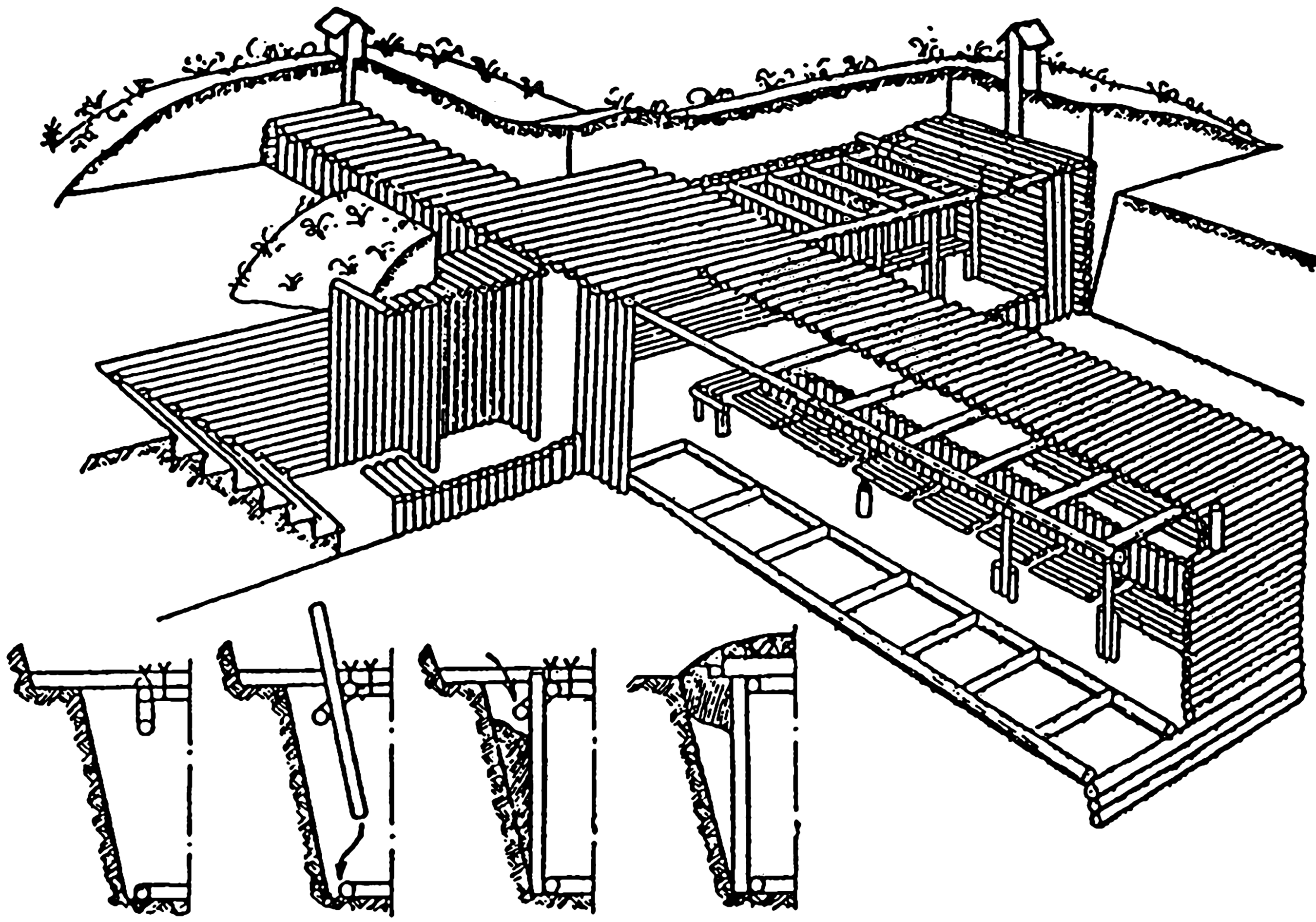
112. These several types of Soviet shelters offer varying degrees of protection against blast and fallout. According to Soviet planning, the type of shelter, its location, and the protection afforded are functions of the priority assigned to the survival of the protected personnel, the likelihood of direct attack or proximity to a target, and the availability of suitable structures that could be adapted as shelters.

113. Detached, bunker-type shelters, adaptable and built-in basement shelters, and subways are available for the protection of both essential workers and the general population. Dual-purpose shelters are also used as underground garages, clubs, and theaters which could be converted quickly to civil defense use.

114. Soviet writings and human sources have also referred to the use of various types of expedient, or temporary, shelters for protection from fallout. They consist of trenches lined with readily available materials and covered with earth. These shelters, which are described in more detail in paragraphs 139-141, are intended primarily for use by the rural population and by the urban population at dispersal and evacuation sites in rural areas. They could also be

Figure 14. Illustration of Soviet Expedient or Hasty Shelter

Diagrams such as this are provided in manuals widely distributed to the Soviet population for use in constructing hasty shelters in dispersal and evacuation areas.



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[USSR, "Antiradiation shelters in rural areas", 1972.]

or evacuee. In práctice, we believe—and emigrés have indicated—that conditions would be much more congested. Details on equipment and supplies for evacuees (including food, water, medicine, and fuel) are discussed later in this chapter.

134. *Time Requirements for Evacuation.* Soviet sources call for evacuation of Soviet cities within the "special period" (a period of warning) preceding an attack, and imply that the evacuation time would be about 72 hours. Soviet authorities have not published their assessment of actual time which would be required for evacuation of the nonessential population. Several US studies have addressed the speed with which the Soviets could complete their evacuation actions. A 1969 RAND study estimated that 100 million urban residents [27] could be evacuated in four days under optimum conditions, using only half of the available 1970 transportation capacity. A 1976 Defense Intelligence Agency study of the evacuation of 12 selected Soviet cities concluded that, under the most favorable conditions, the Soviets have a physical capability to evacuate most of the 12 cities within three to four days after movement begins. The major assumptions used in the DIA study were:

— 70 percent of population evacuated, 30 percent dispersed;

— two shifts working in essential industries and services;

— a six-hour alert preceding actual movements (this period of alert has been tested in Soviet exercises); and

— no other complications, such as panic, severe disruption of transport systems, or adverse weather conditions.

Figures 18, 19, and 20 and Table V summarize the findings of the DIA dispersal and evacuation study.

[27] This number of urban inhabitants equals the total population of some 450 cities with populations of 50,000 or more and includes almost all major administrative, residential, communication, and transportation centers.

TABLE V

DIA-Estimated Time Required for Evacuation of Twelve Selected Soviet Cities

City	Numbers evacuated (thousands) [1]	Maximum distance (km)	(nm)	Estimated time required after movement begins (hours) [2]	Modes of transport
Leningrad	2,673	[3]		117+	mostly rail, some maritime
Kiev	1,407	110	60	36	rail and highway
Tashkent	1,158	260	140	81	rail
Gor'kiy	914	315	170	75	rail and highway
Odessa	718	[4]		58	mostly rail, some maritime
Dnepropetrovsk	684	185	100	57	rail
Khabarovsk	351	410 [5]	220 [5]	56	rail
Orenburg	288	185	100	47	rail
Kishinev	331	75	40	39	rail and highway
Sevastopol'	187	165	90	29	highway
Angarsk	164	410 [5]	220 [5]	42	rail
Kirovabad	141	95	50	25	rail

[1] Represents 70 percent of city's inhabitants.

[2] Movement begins six hours after the alert. Methodology utilized in calculating evacuation times considers variables such as running speeds, loading and unloading rates, and sequences of unloading dictated by availability of facilities. Since these variables are not known quantities but judgments based on available evidence, the resulting figures for total evacuation time are approximate rather than exact values.

[3] Leningrad can accommodate some 90 large oceangoing ships which could offload evacuees at various ports along the Baltic coast, but a cycle time of three to four days is estimated before ships can return for more evacuees.

[4] Odessa, which can handle some 38 oceangoing ships, could offload evacuees in Romania and Bulgaria, but the cycle time for return of ships is four or more days.

[5] Distances for Khabarovsk and Angarsk are greater than for larger cities because of low population density in surrounding areas.

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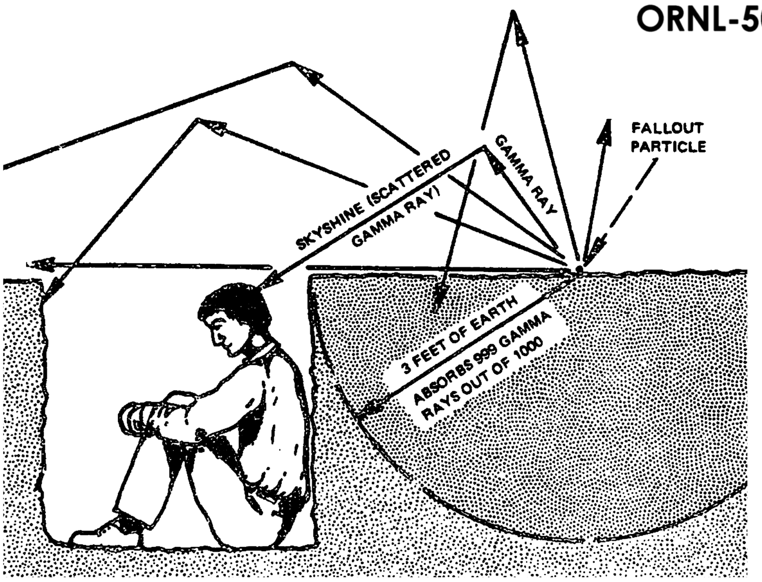
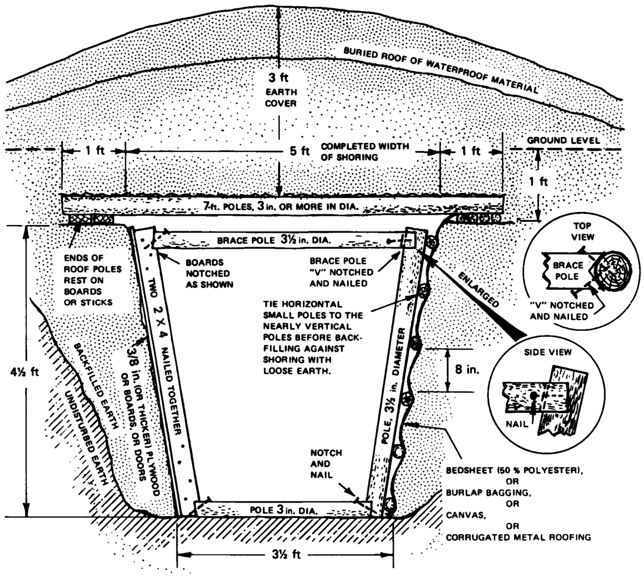
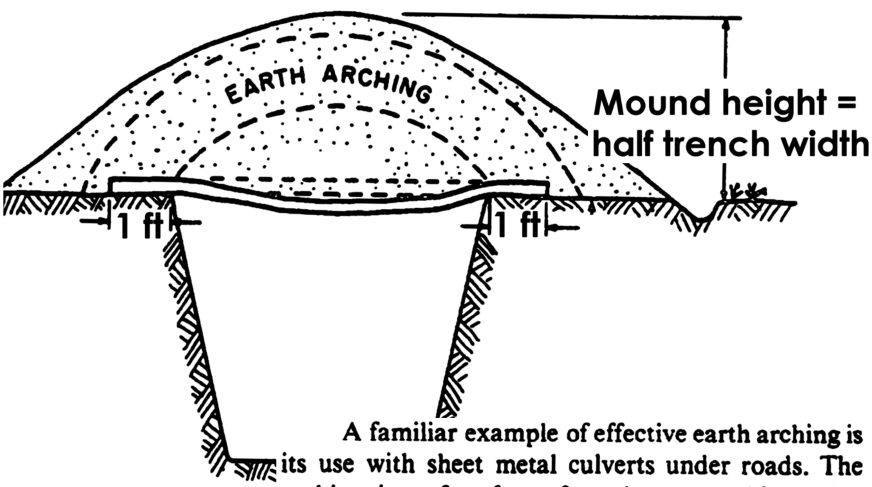


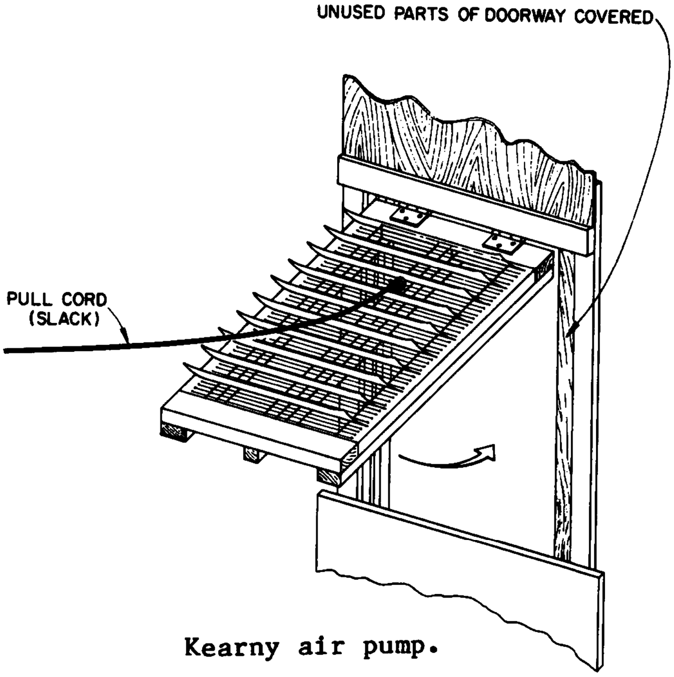
Methods for shoring a trench shelter.



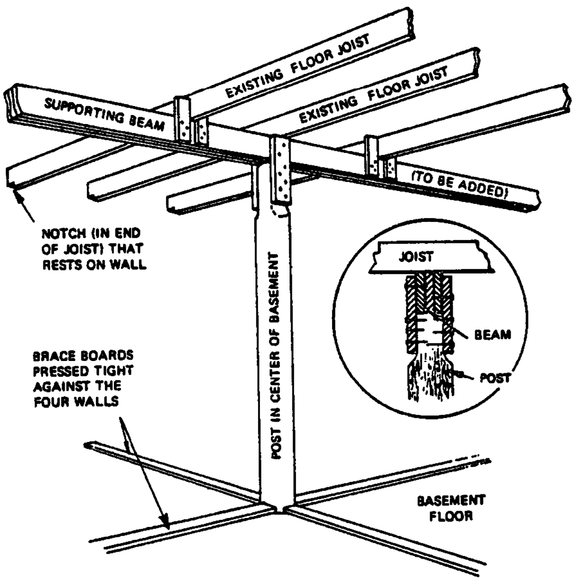
EARTH ARCHING USED TO STRENGTHEN SHELTERS

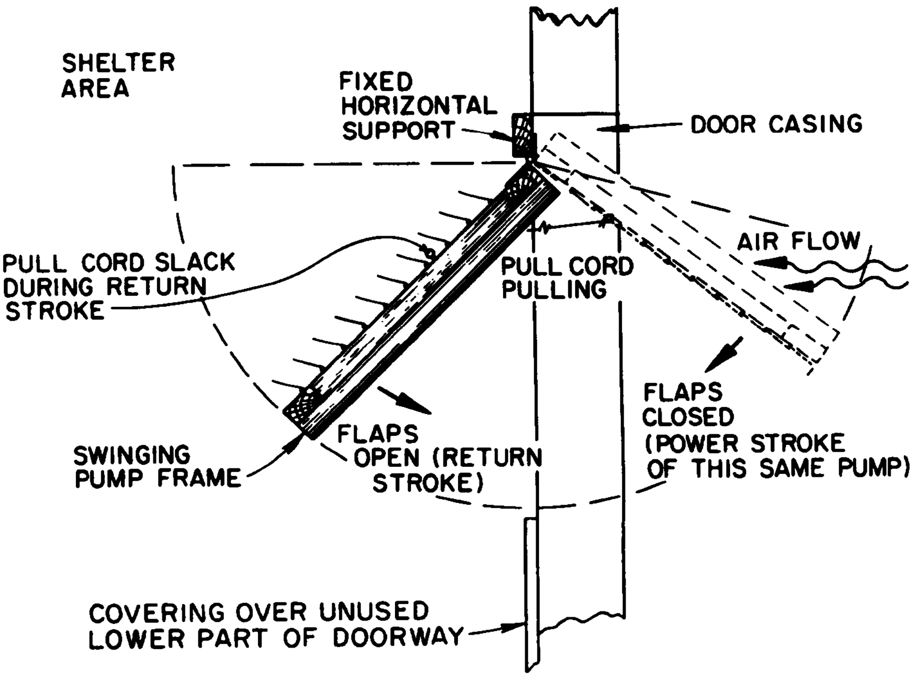


A familiar example of effective earth arching is its use with sheet metal culverts under roads. The arching in a few feet of earth over a thin-walled culvert prevents it from being crushed by the weight of heavy vehicles.



Kearny air pump.





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TM 23-200/OPNAV INSTRUCTION 03400.1C/AFM 136-1/FMFM 11-2

THIS PUBLICATION SUPERSEDES TM 23-200, OPNAV INSTRUCTION 03400.1B, AFM 136-1/NAVMC 1104 REV, NOVEMBER 1957, INCLUDING CHANGE 1, 24 JUNE 1960 AND CHANGE 2, 3 OCTOBER 1960 THERETO.

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R

CAPABILITIES
OF
NUCLEAR WEAPONS [U]

United States Government Printing Office
Washington: 1964

[redacted]

GROUP-3
Downgraded at 12 year intervals;
Not automatically declassified.

Table 7-1 Estimated Casualty Production in Structures for Various Degrees of Structural Damage

Structural damage	Killed outright	Serious injury (hospitalization)	Light injury (No hospitalization)
		Percent*	
1-2 story brick homes (high explosive data):			
Severe damage	25	20	10
Moderate damage	<5	10	5
Light damage		<5	<5
Reinforced-concrete buildings (Japanese data, nuclear):			
Severe damage	100		
Moderate damage	10	15	20
Light damage	<5	<5	15

*These percentages do not include the casualties that may result from fires, asphyxiation, and other causes from failure to extricate trapped personnel. The numbers represent the estimated percentage of casualties expected at the maximum range where the specified structural damage occurs. For the distances at which these degrees of damage occur for various yields see Chapter 8.

example, although such effects as capacitor discharge are usually referred to as transient effects, the time constant for recovery of the capacitor to its normal operating potential may be so long that recovery may not be effected before the mission of the system involved is complete. In this instance the effect would be classified as permanent damage even though the capacitor itself would have eventually completely recovered.

ELECTROMAGNETIC PULSE RADIATION DAMAGE

a. General. Permanent damage due to overheating or puncturing of insulation is possible where the electromagnetic pulse energy is high, where the induced voltage triggers an electrical fault and the damage energy is supplied by the affected system, or where the electromagnetic pulse energy is carried for some distance along a cable or line as a power surge.

Interruption of service may occur where the voltage induced in a cable or line causes fuses to blow or circuit breakers to trip. This may take place many miles away from the point of detonation due to transmission of the surge. An interruption could also result if an electronically stored program were subjected to a strong enough transient electromagnetic field to scramble it.

Transient disturbances to electronic systems may occur in several ways. The electromagnetic pulse may be received via the signal or power lines acting as antennae. Or, the low frequency portion of the pulse may penetrate the enclosures and directly induce transient signals in the circuits.

Many instances of all three kinds of damage, i.e., permanent, interruptive and transient, have been experienced. So far, little if any, correlation of damage with measured electromagnetic field strengths has been established. This has been the result of factors previously described, and of uncertainty of the point where electromagnetic pulse pickup actually occurred in cases where many cables and lines were in use for power, signal, control and mechanical purposes.

b. Power System Damage. Very regular zero-time tripping of power circuit breakers at a substation more than 30 miles away was observed on one series of tests. Standby personnel were always posted to reset the breakers to keep electrical equipment functioning. Within a mile of ground zero, pinholes in underground cable insulation have frequently been found. Such cables carried up to 4160 volts.

At power distribution stations, porcelain cutouts have been observed to arc over and the fuses have often blown. At other stations power transformers have been shorted internally or have had insulating bushings destroyed. Ordinary lightning protective devices provided inadequate protection against the electromagnetic pulse, in those cases.

c. Signal System Damage. Damage to signal systems has also been frequent in the form of burned or fused relays, potentiometers, cable insulation and conductors, as well as blown or damaged meters. In many instances, reviews of the circuits have shown that induced energy caused the damage, rather than triggered system energy. Free ends of cable pairs have often arced and melted.

d. Electronic System Damage. Oscilloscope presentations have frequently been disturbed or obliterated, even as far as 11 miles from ground zero.

Pulse counters in a timing circuit have been scrambled directly by the induced field (this effect has actually been duplicated in a simulation test in which a 1 mfd capacitor was charged to several thousand volts, then discharged into 10 turns of wire wound around the cabinet). Memory circuits employing magnetic elements may be vulnerable to the magnetic field, H, in a direct manner, as well as to the time derivative of the field.

Elaborate protective measures against electromagnetic effects have been devised, on occasion, such as extensive grounding plate systems, double-walled screen rooms, precautions against forming loops, and special bonding. These measures appeared effective on certain occasions, but on others, when higher yield weapons were tested, the precautions did not always suffice.

General recommendations for protection against electromagnetic pulse radiation damage cannot yet be made. Protective measures to be taken will depend principally upon the nature of the target and the degree of protection required.

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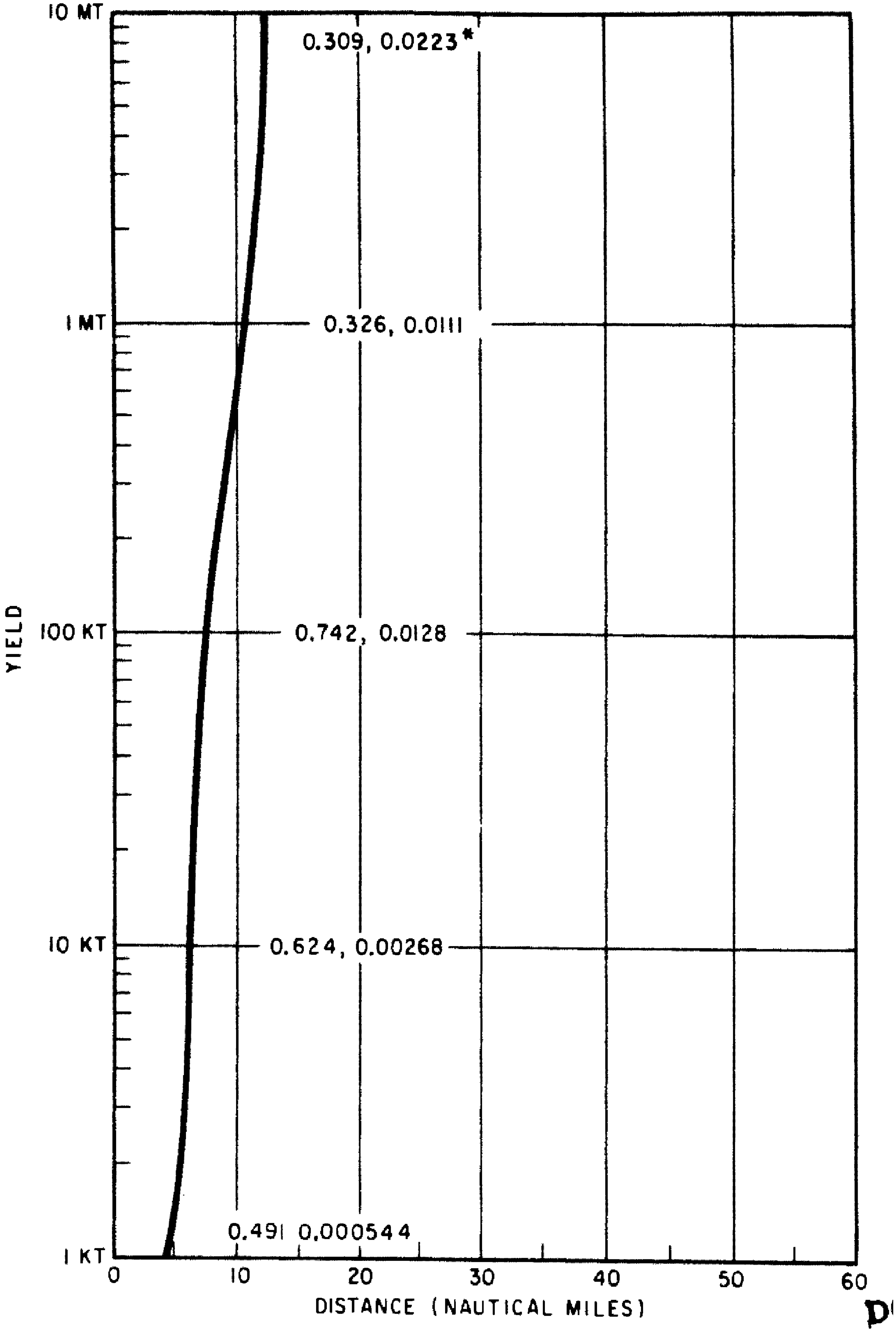

*EACH PAIR OF VALUES INDICATE, RESPECTIVELY, CALORIES AT THE CENTER OF THE IMAGE AND CALORIES ON THE LENS SURFACE

SEA LEVEL (BURST AND OBSERVER)
WATER VAPOR PRESSURE: 5mm HG
PUPILLARY DIAMETER: 3mm

Figure 7-3. Yield vs. Maximum Distance at which a Retinal Burn will be Formed. Visibility 10 Statute Miles; Standard Normal Day, and Daytime Adapted Eye

13-5 FIRE IN URBAN AREAS. The employment of an air burst weapon over urban areas may produce, besides blast damage, mass fires which, under proper conditions, materially increase the degree and extent of damage. The behavior of such fires, whether they are of primary or secondary origin, follows the pattern of fires in forest and wildland areas. The burning potential for urban areas varies with weather conditions, much as for wildlands; however, the fire season as such is not as pronounced as in wildlands. During those seasons when weather conditions may reduce exterior potentials to zero, dwellings are usually heated, so that interior fuels are dried out. Fire incidence and subsequent fire buildup depend also upon the amount and distribution of flammable material used in interior furnishing and building construction, the incidence of interior kindling fuels, and the relative cleanliness of the living habits of the population.

13-6 Ignition Points. A survey of metropolitan areas in the United States indicates that the incidence of exterior ignition points can be correlated with urban land use. Table 13-1 presents a relative tabulation based on exterior kindling fuels. Newspapers and other paper products account for 70 percent of the total, and dry grass and leaves account for another 10 percent in residential areas. Most other exterior kindling fuels are present in small percentages or require radiant exposures in excess of 10 cal/cm^2 for ignition. Weathered and badly checked fences and building exteriors that contain appreciable dry rot constitute an ignition hazard. The tabulation presented in table 13-1 is not representative of European cities and other areas where fuel is at a premium, or where extensive use is made of stone, brick, masonry, and heavy timber construction. Multistory buildings and narrow streets reduce both interior and exterior primary ignitions, because such ignitions are proportional to the amount of sky seen from the location of the probable ignition point.

Table 13-1 Relative Incidence of Ignitions in Metropolitan Areas of the United States by Land Use (Based on Exterior Kindling Fuels).

Land use	Relative incidence
Downtown retail	1.0
Large manufacturing*	1.4
Good residential	1.6
Small manufacturing	3.8
Poor residential	5.2
Neighborhood retail	5.5
Waterfront areas	8.0
Slum residential	11.7
Wholesaler	15.1

* May be likened to a typical fixed military installation in the Z.1.

13-7 Humidity Effects. Because paper is the major exterior kindling fuel and is also an important interior fuel, the extent of ignitions may be estimated from the minimum radiant exposure requirements for newspaper. Figure 13-1 shows the radiant exposure required to ignite darkly printed picture areas and printed text areas of newspaper at 50% relative humidity. The effect of relative humidity on the ignition of this cellulosic fuel can be estimated by multiplying the ignition radiant exposures for the dry material by the factor, $1 + 0.005\,H$, where H is the relative humidity in percent. Maximum fire effects occur during daily periods of lowest relative humidity, usually mid-afternoon. Guides for estimating urban burning potentials are given in figures 13-2 and 13-3. Figure 13-2, which gives burning potential for urban areas when central heating is not in use, represents approximate values of wind speed and average daytime relative humidity conditions corresponding to low, dangerous, and critical burning potentials according to the following definitions:

Low. Slow burning fires; fire can be controlled at will. Control action can be on unit structure basis.

Dangerous. Fires burn rapidly; individual building fires combine to form an area fire. Organized action needed to confine fire to area originally ignited.

[redacted]

Table 13-2 Critical Radiant Exposures for Damage to Various Materials

ambient relative humidity of 65 percent

Material	Weight (oz/sq yd)	Color	Effect on Material	Radiant Exposure (cal/cm²) 40 kt	1 mt	10 mt
Clothing Fabrics						
Cotton	8	White	Ignites	32	48	85
		Khaki	Tears on flexing	17	27	34
			Ignites	20	30	39
		Olive	Tears on flexing	9	14	21
			Ignites	14	19	21
		Dark Blue	Tears on flexing	11	14	17
			Ignites	14	19	21
Cotton-nylon Mixture	5	Olive	Tears on flexing	8	15	17
			Ignites	12	28	53
Wool	8	White	Tears on flexing	14	25	38
		Khaki	Tears on flexing	14	24	34
		Olive	Tears on flexing	9	13	19
		Dark Blue	Tears on flexing	8	12	18
	20	Dark Blue	Tears on flexing	14	20	26
Rainwear (double neo-prene coated nylon twill)	9	Olive	Begins to melt	5	9	13
			Tears on flexing	8	14	22
Tinder Materials						
Paper, bond, typing, new (white)			Ignites	24	30	50
Newspaper, printed text			Ignites	6	8	15
Newsprint, dark picture area			Ignites	5	7	12
Paper, kraft, single sheet (tan)			Ignites	10	13	20
Rags (black, cotton)			Ignites	10	15	20
Rags (black, rayon)			Ignites	9	14	21
Tent Material						
Canvas, white, 12 oz/sq yd			Ignites	13	28	51
Canvas, OD, 12 oz/sq yd			Ignites	12	18	28
Aluminum aircraft Skin (0.020 in. thick) coated with 0.002 in. of standard white aircraft paint			Blisters	15	30	40
Sandbags, cotton, canvas, dry, filled			Failure	10	18	32
Construction Materials						
Roll Roofing, mineral surface			Ignites	—	>34	>116
Roll Roofing, smooth surface			Ignites	—	30	77
Plywood, douglas fir			Flaming during exposure	9	16	20
Sand, coral			Explosion*	15	27	47
Sand, siliceous			Explosion*	11	19	35
Rubber, pale latex			Ignites	50	80	110
Rubber, black			Ignites	10	20	25

* Popcorning

 [redacted]

Table 7-2 Radiant Exposures for Burns Under Clothing

Clothing	Burn	40 kt	1 mt	10 mt
		Radiant exposures[1,2]		
Bare skin	none	2.0	2.6	2.9
	1°	2.6	3.1	3.5
	2°	4.6	6.3	7.0
Summer uniform (2 layers of light porous fabric)	none	5	6	7
	1°	10	16	21
	2°	12	20	26
Winter uniform (2 to 5 layers of tightly woven fabric)	none	7	10	12
	1°	13	21	29
	2°	16	26	36
Sub-artic and arctic (3 to 8 layers of tightly woven fabric)[3]	none	15	25	40
	1°	15	25	40
	2°	15	25	40

[1] Expressed in cal/cm^2 incident on skin or outer surface of clothing when the inner layer of the clothing is spaced 0.5 cm from the skin and when at least the first 70% of the thermal pulse is received normal to the surface.

[2] These values are sensitively dependent on many variables and are probably correct to within ±50% for the range of normal military situations.

[3] Burns to personnel wearing these heavy uniforms will occur only by contact with flaming or glowing outer garments. Some systems require in excess of 100 cal/cm^2 to produce burns by direct transmission of heat through the fabrics.

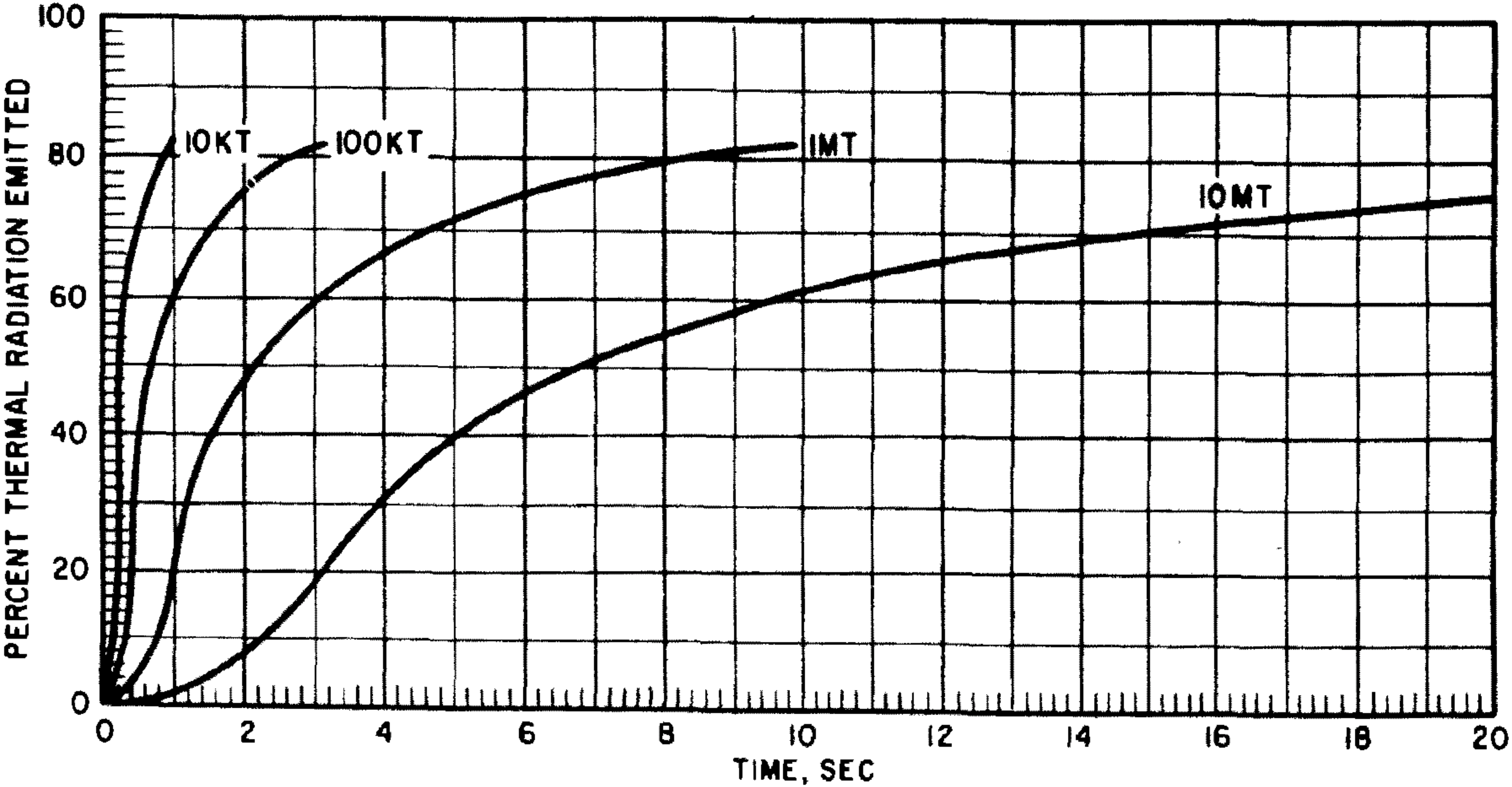

Figure 7-2. Percent Thermal Radiation Emitted vs. Time for Detonations Within the Atmosphere

Teapot-MET (1955)

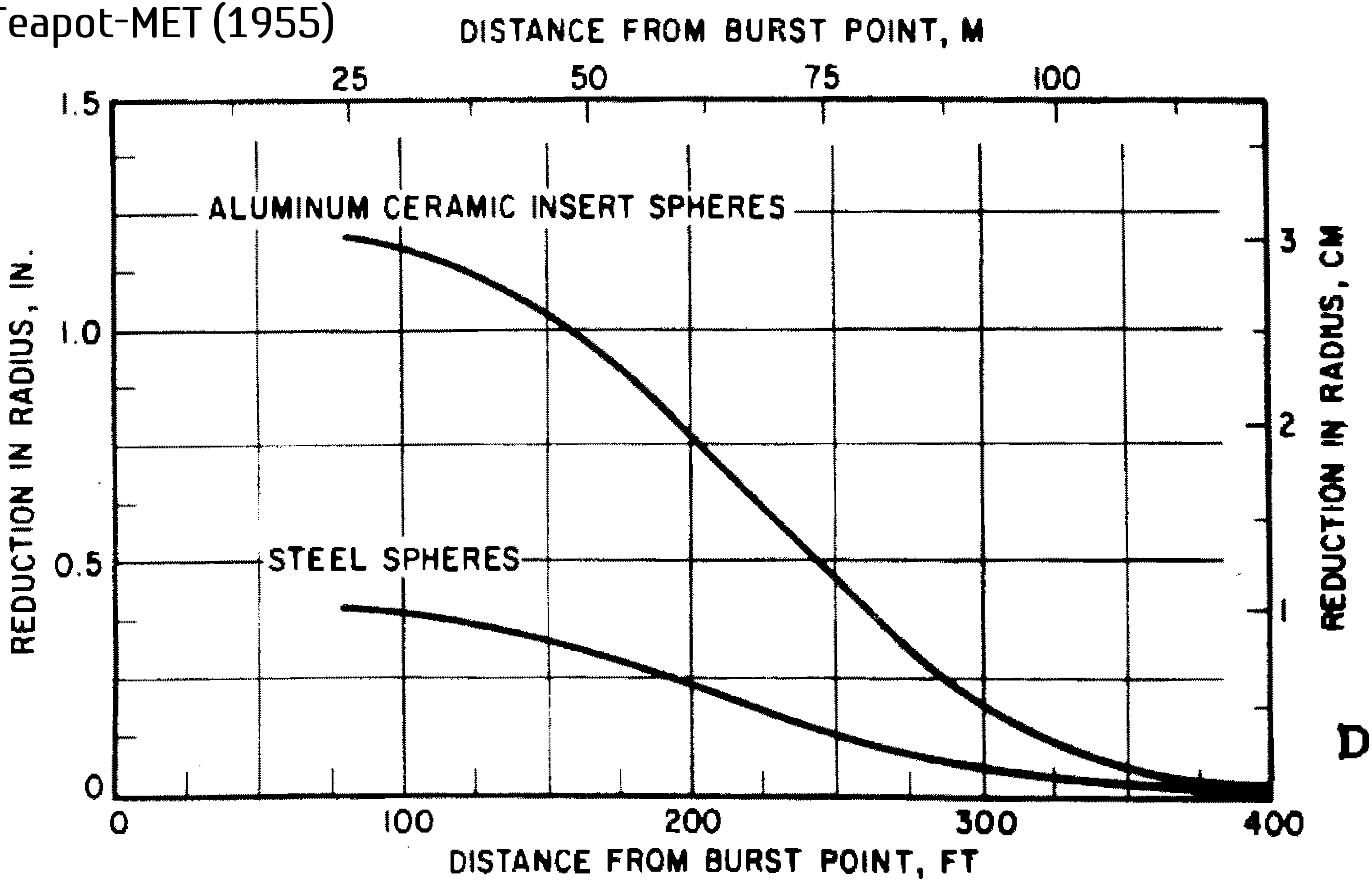

Figure 13-5. Reduction of Sphere Radius with Distance from a 23-kt Burst for Aluminum, Steel, and Ceramic Insert Spheres

Table 7-4 Summary of Clinical Effects of Acute Ionizing Radiation Dose

		Therapeutic range			Lethal range	
		100-200 rems	200-600 rems	600-1000 rems	1000-5000 rems	Over 5000 rems
Range	Subclinical range	Clinical surveillance	Therapy effective	Therapy promising	Therapy palliative	
Incidence of vomiting	None	100 rems: 5% 200 rem:: 50%	300 rems: 100%	100%	Up to 100%	
Delay time	——	3 hours	2 hours	1 hour	30 minutes	
Leading organ	None	Hematopoietic tissue			Gastro-intestinal tract	Central nervous system
Characteristic signs	None	Moderate leukopenia	Severe leukopenia; purpura; hemorrhage; infection. Epilation above 300 rems.		Diarrhea; fever; disturbance of electrolyte balance	Convulsions; tremor; ataxia; lethargy
Critical period postexposure	——	——	4 to 6 weeks		5 to 14 days	1 to 48 hours
Therapy	Reassurance	Reassurance, hematologic surveillance	Blood transfusion; antibiotics	Consider bone marrow transplantation	Maintenance of electrolyte balance	Sedatives
Prognosis	Excellent	Excellent	Good	Guarded	Hopeless	
Convalescent period	None	Several weeks	1-12 months	Long		
Incidence of death	None	None	0-80% (variable)	80-100% (variable)	95-100%	
Death occurs within	——	——	2 months		2 weeks	2 days
Cause of death	——	——	Hemorrhage; infection		Circulatory collapse	Respiratory failure; brain edema

Table 7-5 Dose Transmission Factors (Interior Dose/Exterior Dose)

Geometry	Gamma rays Initial	Gamma rays Residual	*Neutrons*[1]
Foxholes[2]	0.20	0.10	0.30
Underground—3 ft	0.04-0.05	0.0002	0.002-0.01
Builtup city area (in open)	—	0.70	—
Frame house	0.80	0.30-0.60	0.3-0.8
Basement	0.05-0.5	0.05-0.1	0.1-0.8
Multistory building:			
Upper	0.9	0.01	0.9-1.0
Lower	0.3-0.6	0.1	0.9-1.0
Blockhouse walls:			
9 in	0.1	0.007-0.09	0.3-0.5
12 in	0.05-0.09	0.001-0.03	0.2-0.4
24 in	0.01-0.03	0.0001-0.002	0.1-0.2
Factory, 200 x 200 ft	—	0.1-0.2	—
Shelter, partly above grade:			
With earth cover—2 ft	0.02-0.04	0.005-0.02	0.02-0.08
With earth cover—3 ft	0.01-0.02	0.001-0.005	0.01-0.05
Rough Terrain	—	0.4-0.8	—
Tanks: M-24, M-41, Tank Recov. Vehicle M-51, M-74	0.3-0.5	0.2	0.5-0.7
Tanks: M-26, M-47, M-48, T-43E1; Eng. Armd. Vehicles, T-39E2	0.2-0.4	0.1	0.3-0.6
Tractor, crawler, D8 w/blade	1.0	0.4	1.0
1/4-ton truck	1.0	0.8	1.0
3/4-ton truck	1.0	0.6	1.0
2-1/2-ton truck	1.0	0.5-0.6	1.0
Armd. Inf. Vehicle M-59, M-75. and 8P Twin 40mm Gun M-42	0.8-1.2	0.2-0.6	0.8-1.0
SP 105-mm howitzer M-52	0.6-0.8	0.4-0.6	0.8-1.0
Cruisers[3]			
Navigating Bridge	0.12-0.35	0.005-0.2	0.75
Superstructure Deck	0.008-0.25	0.0001-0.1	0.7
Main Deck	0.005-0.25	0.00003-0.1	0.7
Second Deck	0.0002-0.2	0-0.07	0.6
First Platform	0.0002-0.2	0-0.07	0.2-0.3
Second Platform	0.0001-0.10	0-0.01	0.05-0.15
Destroyer[3]			
Navigating Bridge	0.25-0.40	0.1-0.2	0.85
Superstructure Deck	0.015-0.40	0.00025-0.2	0.8-0.85
Main Deck	0.008-0.34	0.0001-0.2	0.75-0.8
First Platform	0.001-0.25	0-0.1	0.75-0.8
Second Platform	0.0005-0.20	0-0.07	0.5-0.75

[1] Estimated values.

[2] No line-of-sight radiation received.

[3] Assuming a beam-on orientation.

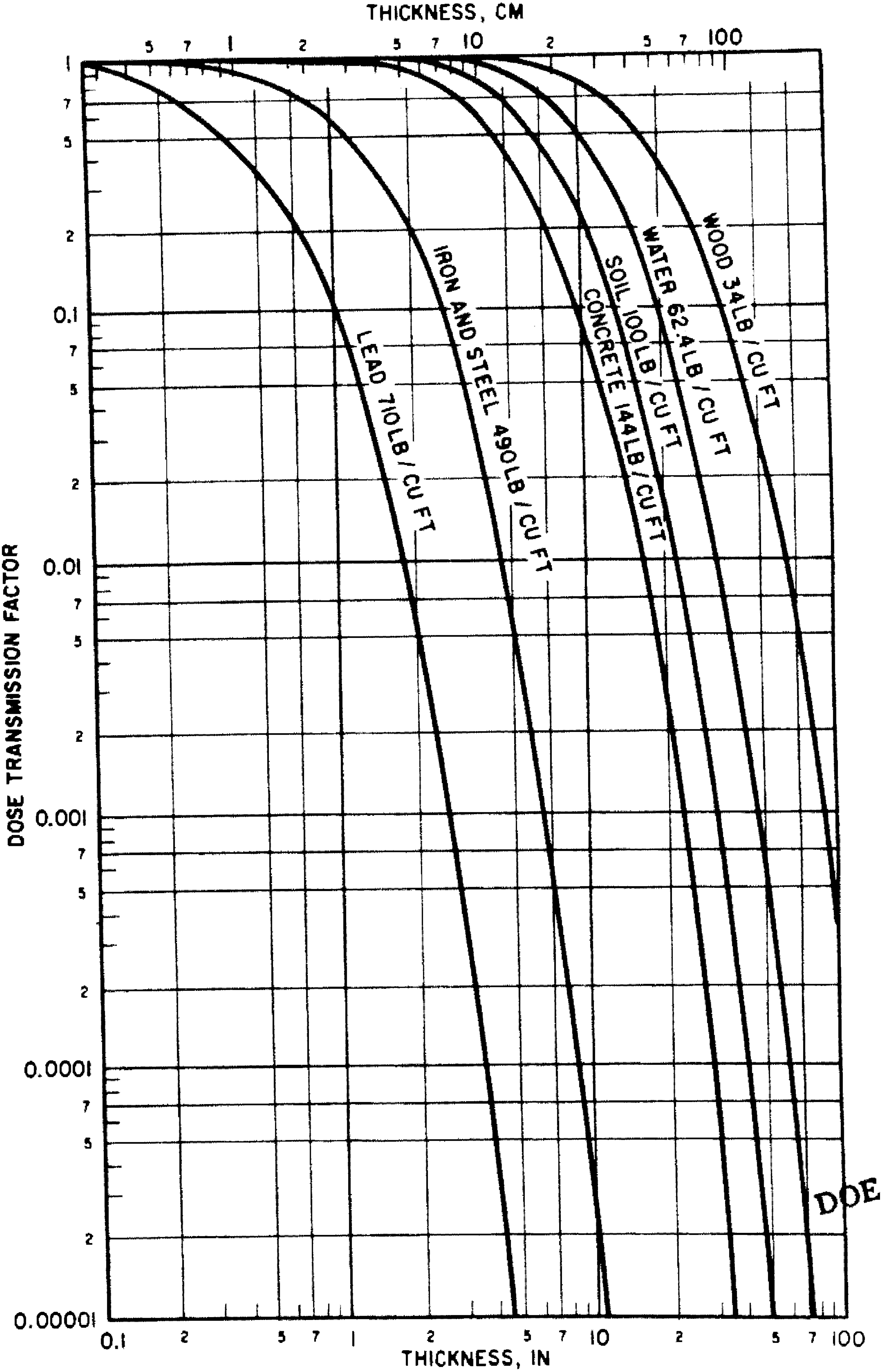

Figure 7-12. Shielding from Residual Gamma Radiation

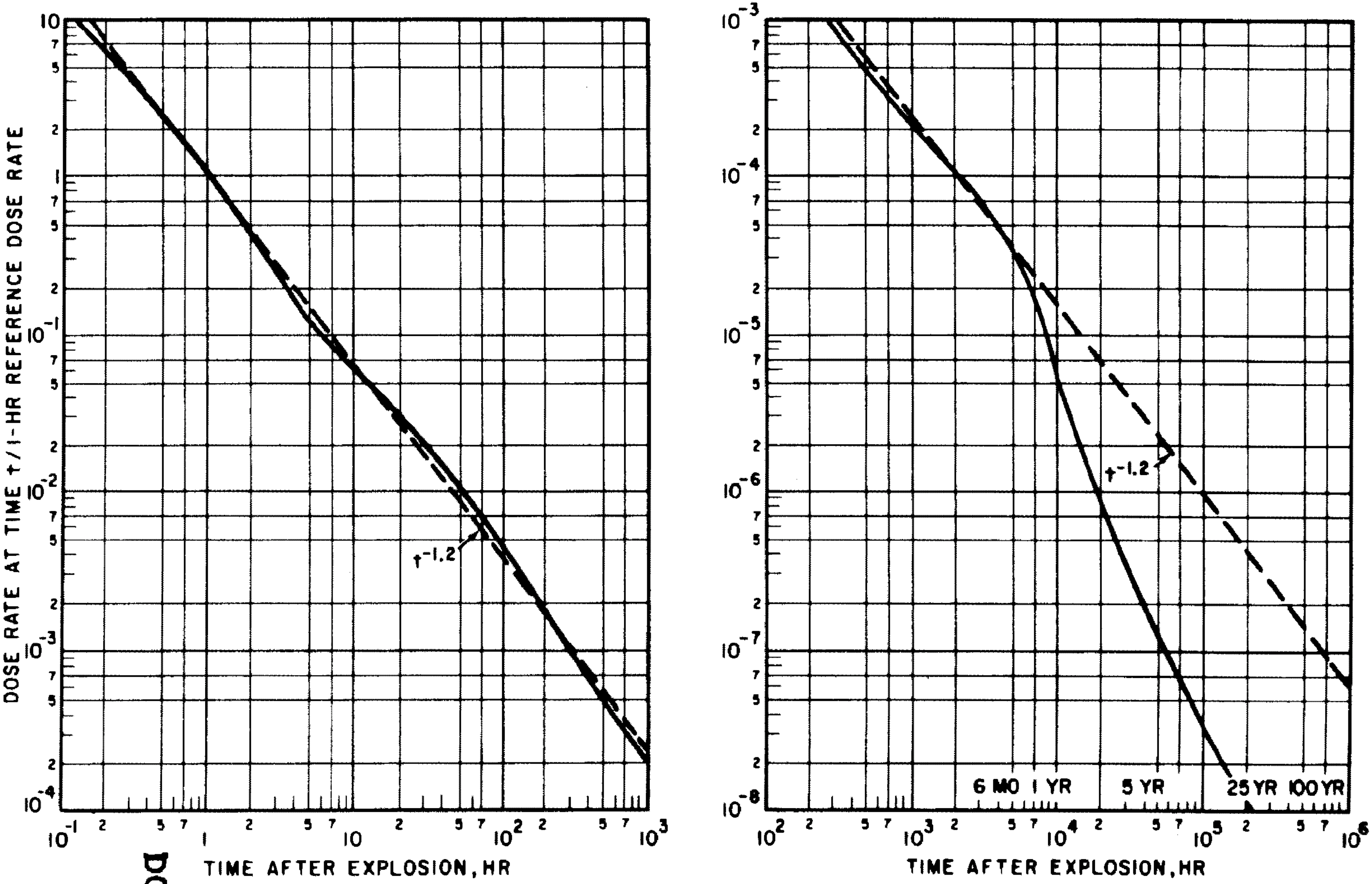

Figure 4-21. Fission-product Decay Factors Normalized to Unity, 1 hr after Detonation

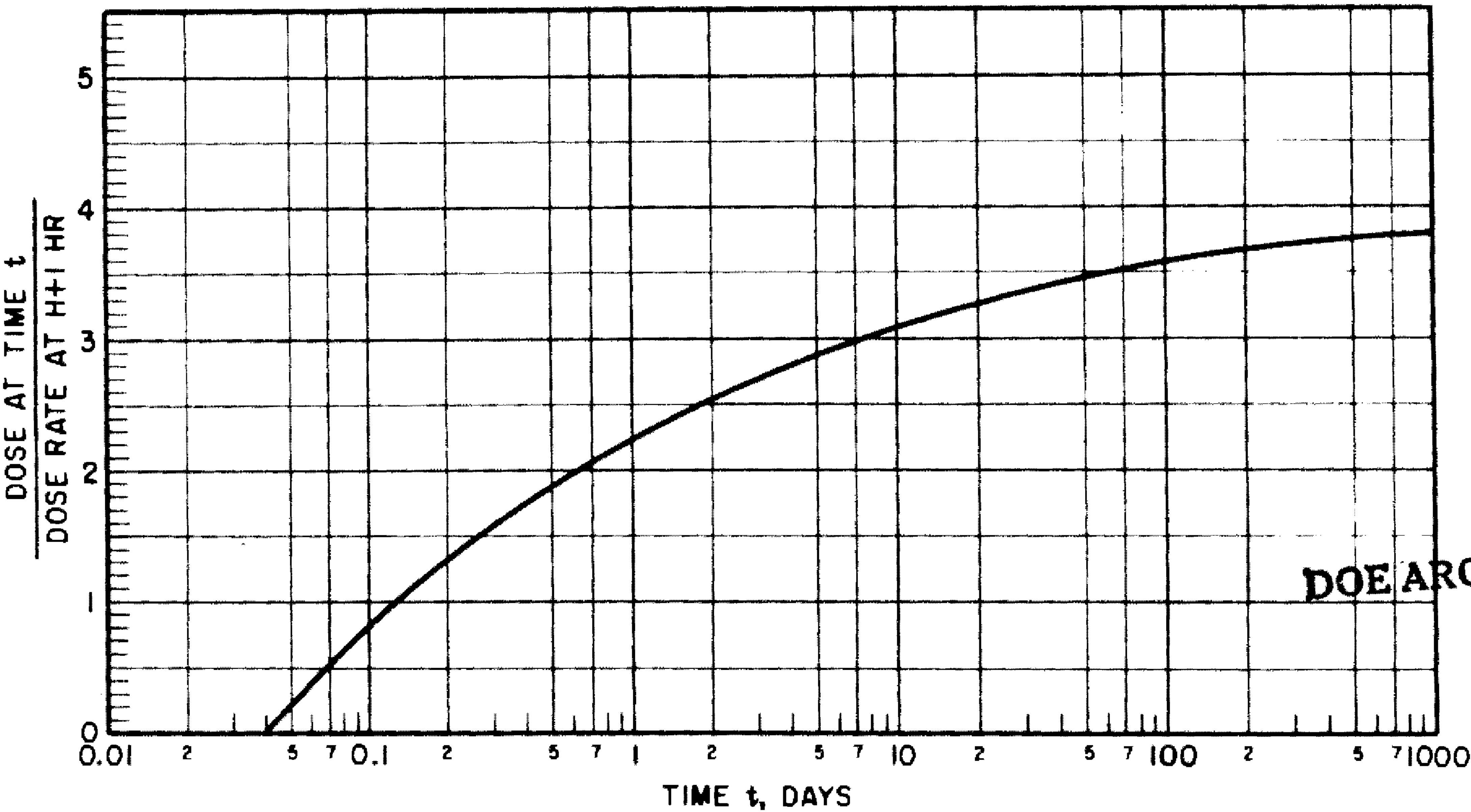

Figure 4-22. Normalized Theoretical Dose Accumulated in a Fallout-contaminated Area from $H + 1$ hr to $H + 1000$ Days

4-13 AIR BURST. The surface contamination effects of fallout from an air-burst weapon are militarily insignificant in most cases because the bomb cloud carries most of the radioactive bomb debris to high altitudes. In general, by the time this material can fall back to earth, dilution and radioactive decay decreases the activity to levels that are no longer militarily important. An exception may occur in the case of a small-yield weapon burst in the rain, where the scavenging effect of the precipitation may cause a rainout of radioactive material that will be hazardous to personnel located downwind and downhill, and outside the hazard area of initial radiation and other effects. Although the range of weapon yields for which rainout may become hazardous is not large, quantitative treatment of the problem is difficult. The contamination pattern on the ground depends upon the scavenging effect of precipitation on suspended fission products in the atmoshere, and the flow and ground absorption of rain water after reaching the ground.

Some of the factors that influence the scavenging effect are:

(1) Height and extent of the rain cloud

(2) Raindrop size and distribution

(3) Rate of rainfall

(4) Duration of precipitation

(5) Position of the nuclear cloud relative to the precipitation

(6) Hygroscopic character of the fission products

(7) Solubility of the fission products

(8) Size of the fission fragments

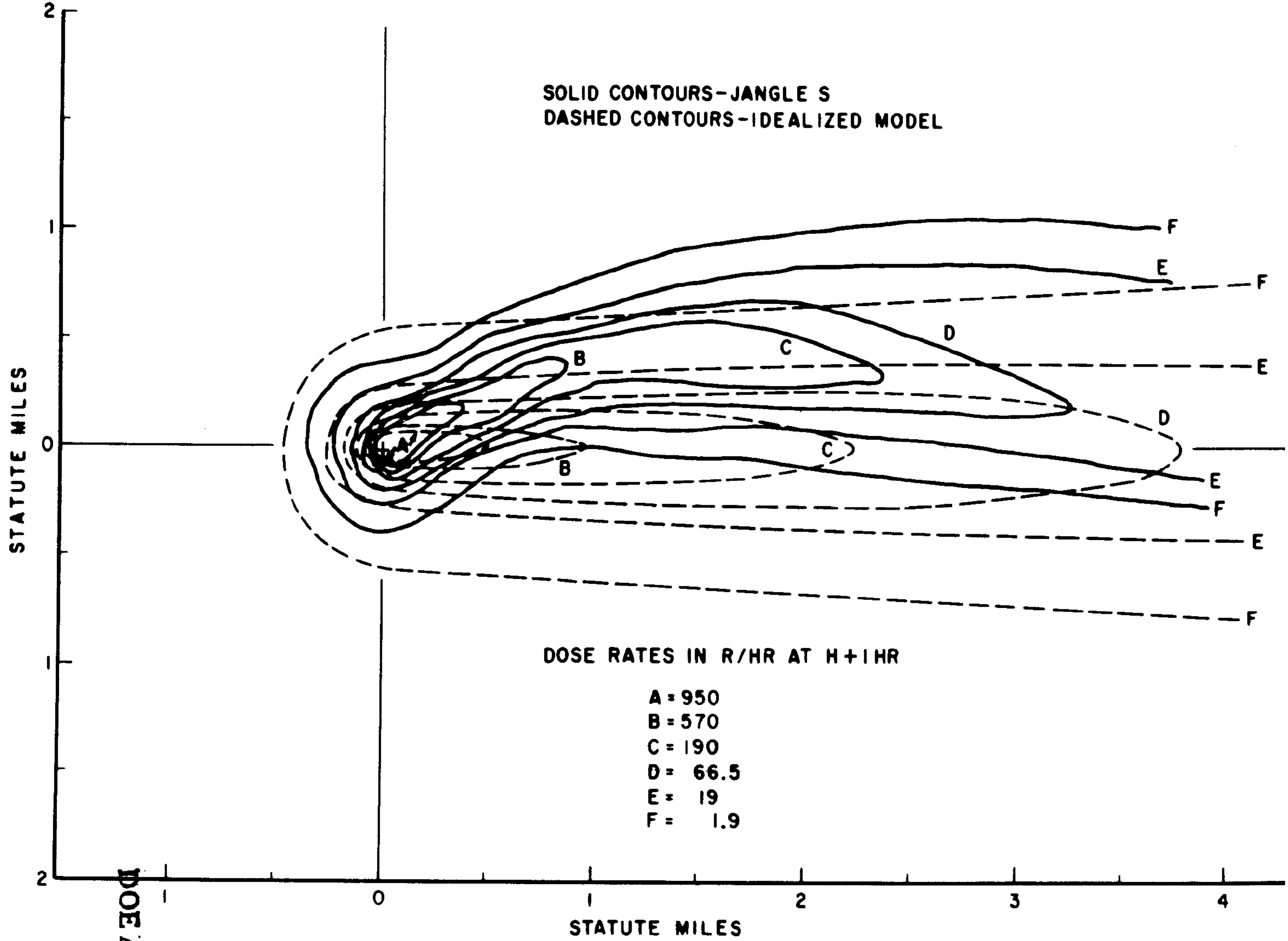

Figure 4-3. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1.2 kt and Effective Wind of 20 knots

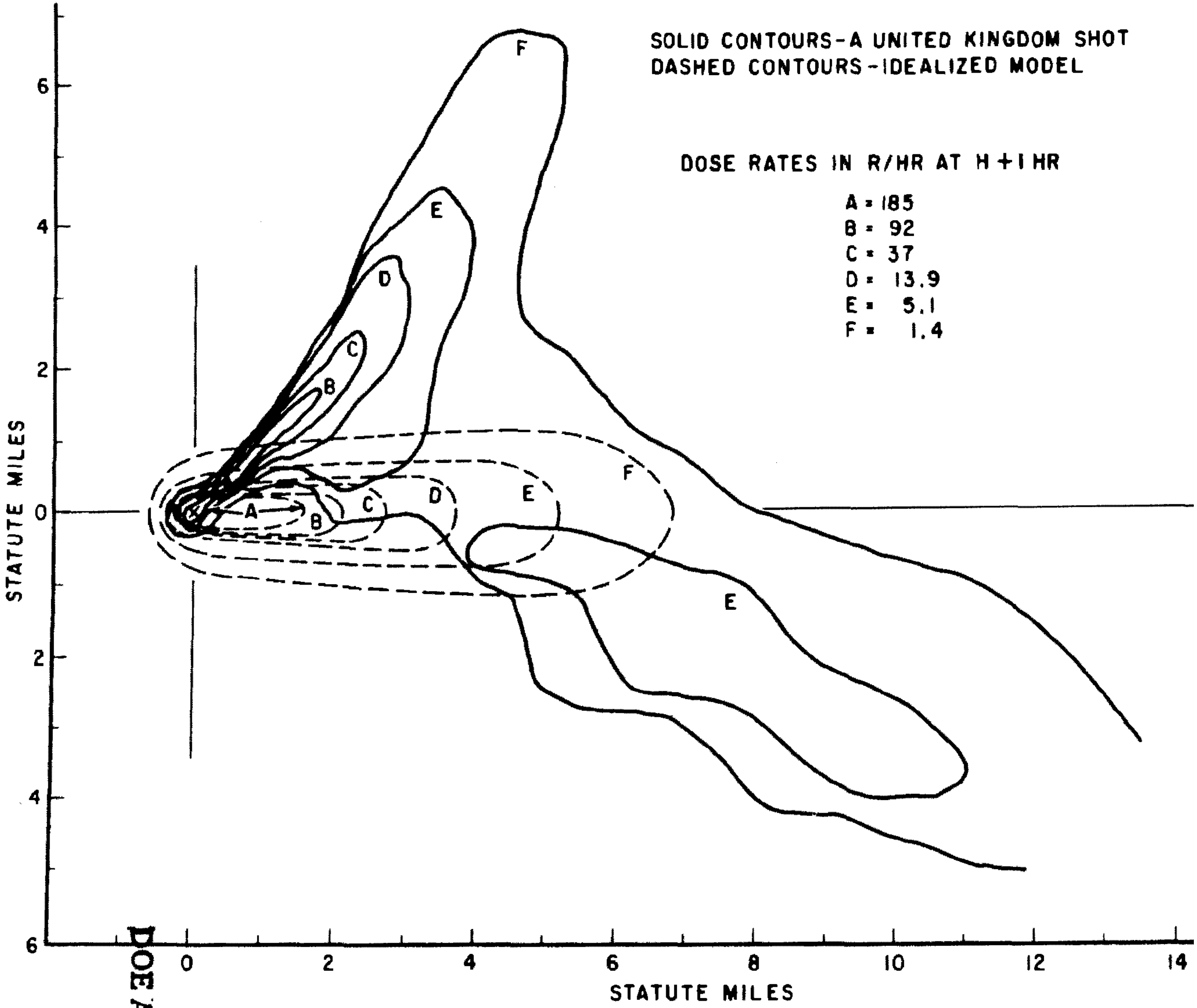

Figure 4-4. Comparison of Actual Fallout Contours with Idealized Model for a Yield of 1 kt and Effective Wind of 10 knots

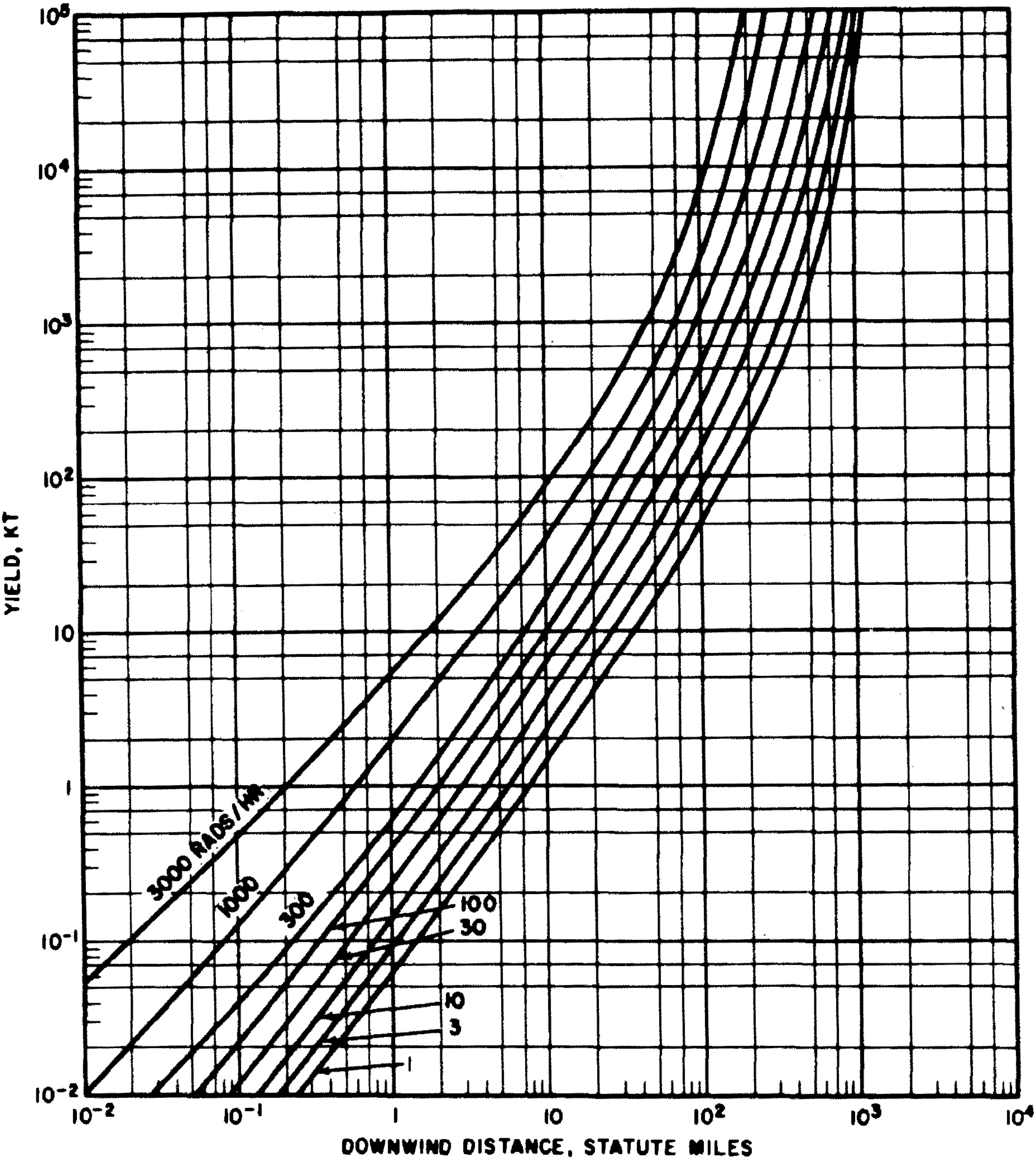

Figure 4-23. Yield vs. Downwind Distance, 10-knot Effective Wind

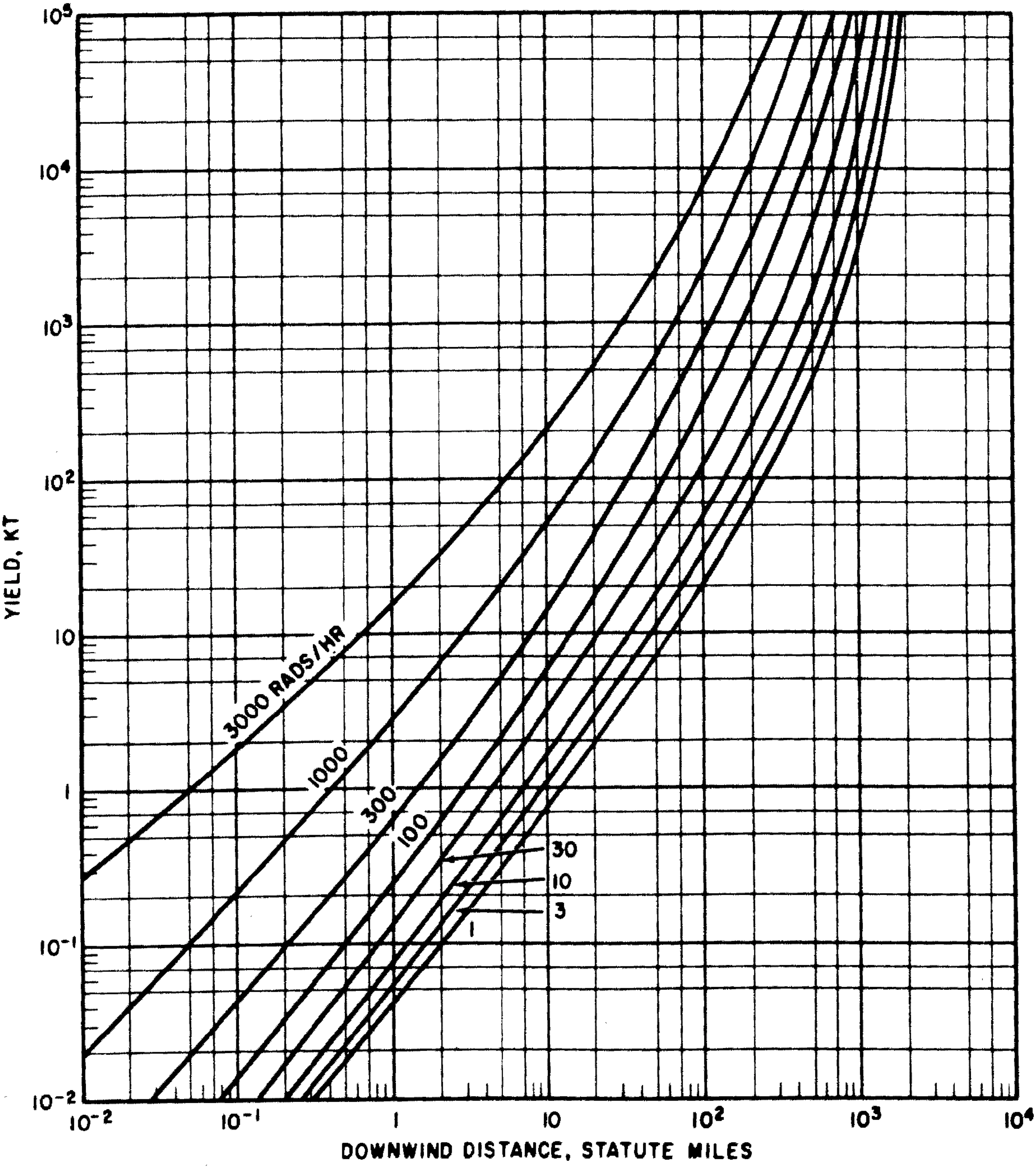

Figure 4-24. Yield vs. Downwind Distance, 20-knot Effective Wind

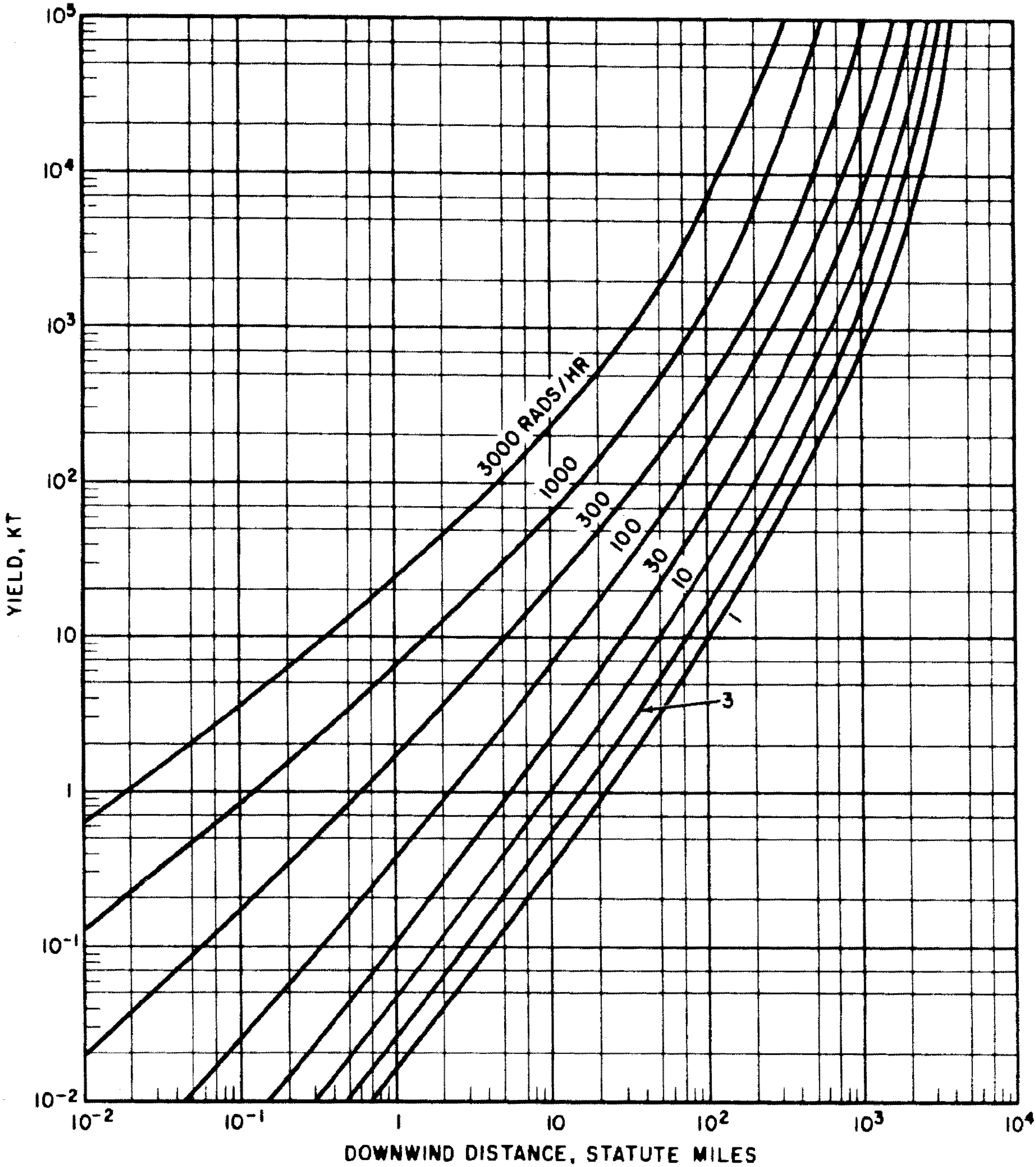

Figure 4-25. Yield vs. Downwind Distance, 40-knot Effective Wind

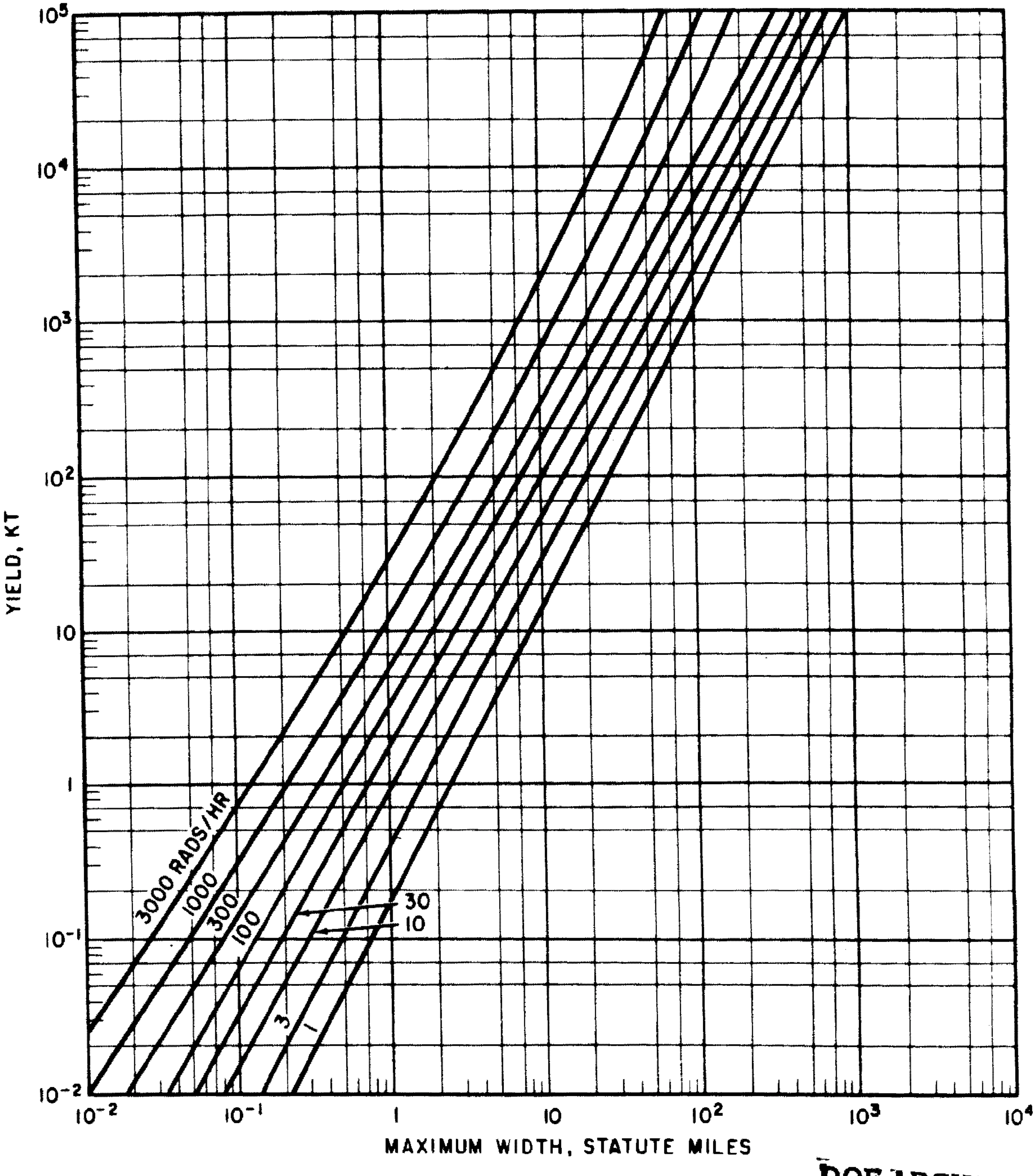

Figure 4-27. Yield vs. Maximum Width, 10-knot Effective Wind

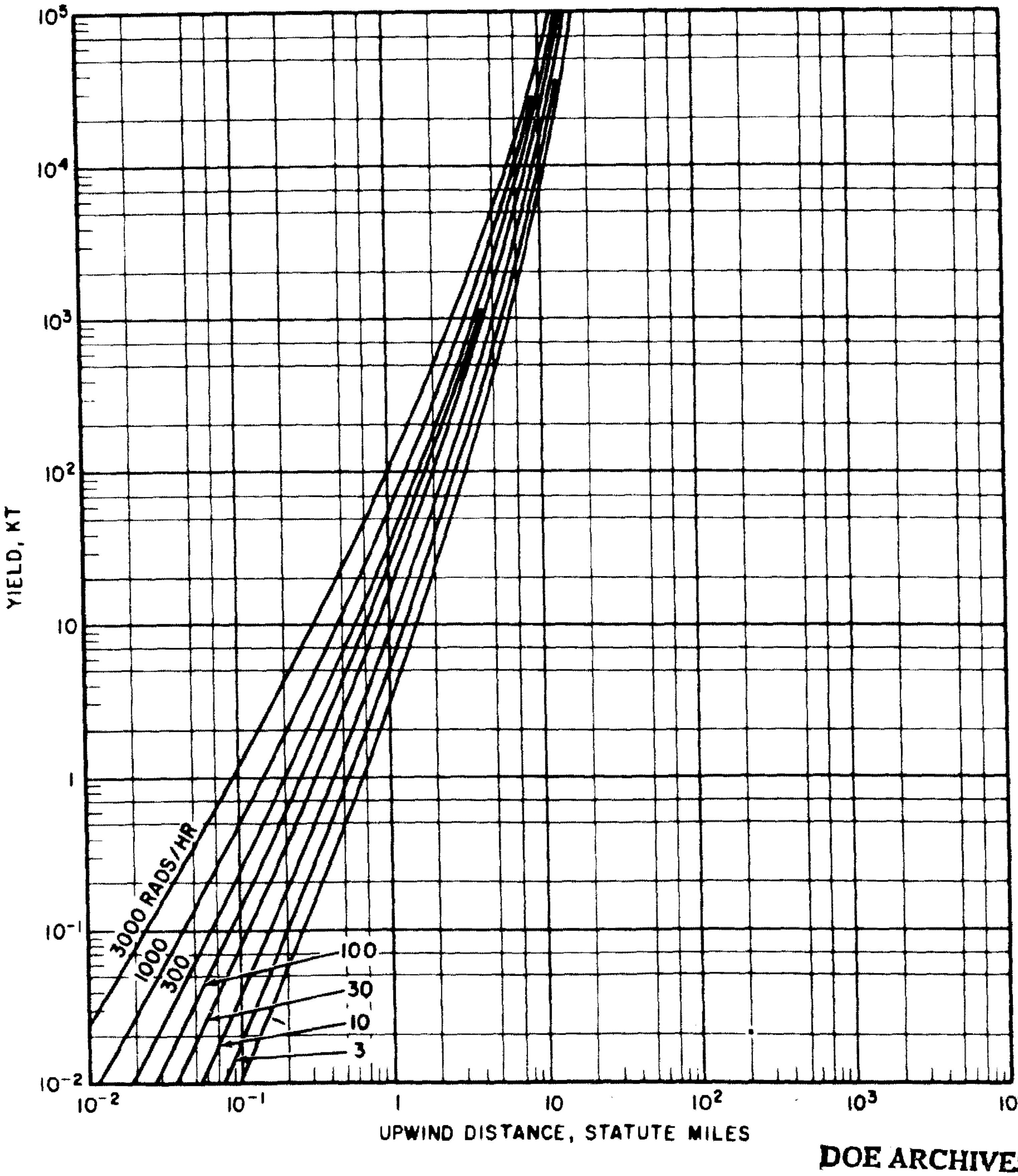

Figure 4-31. Yield vs. Upwind Distance, 10-knot Effective Wind

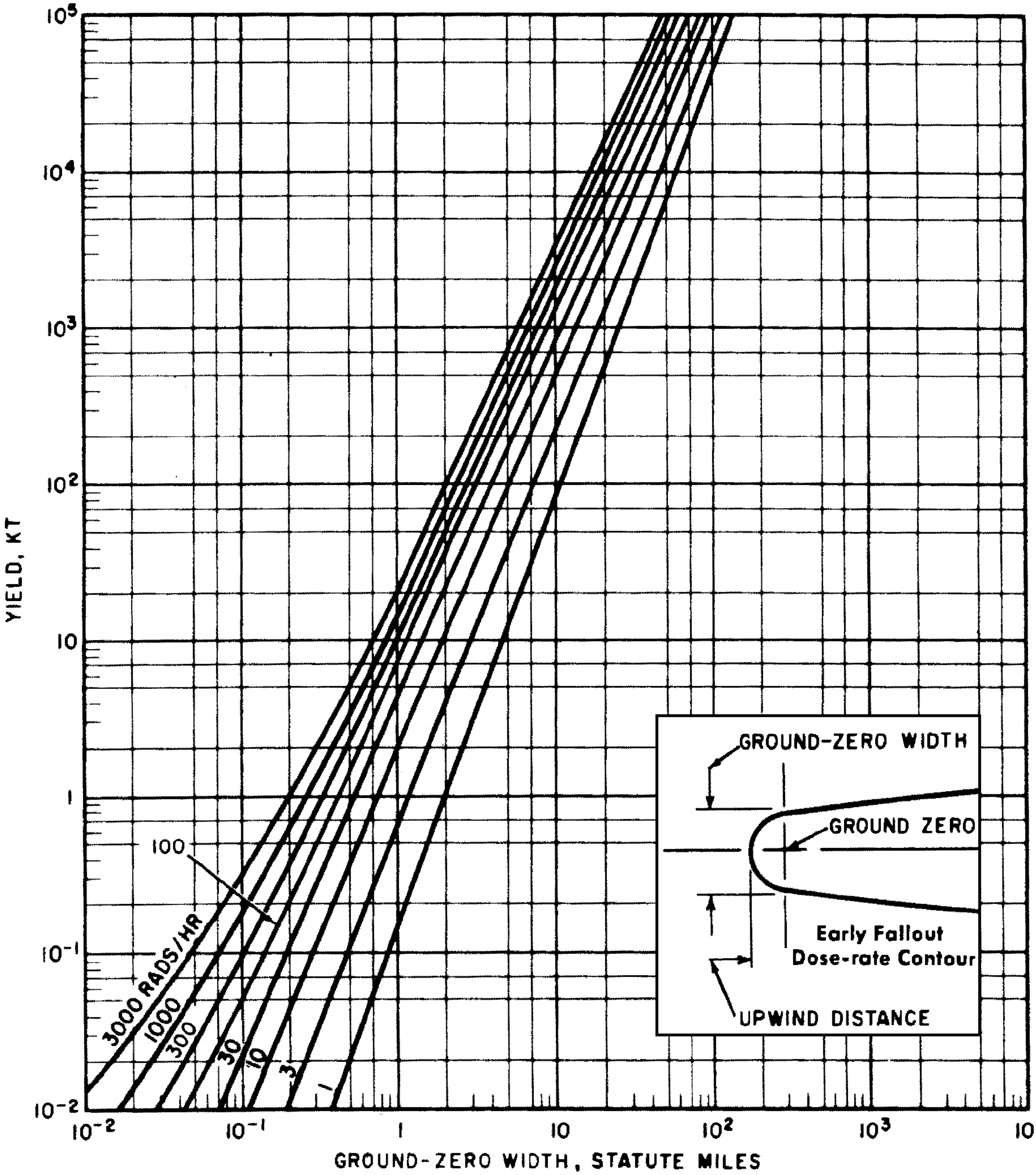

Figure 4-39. Yield vs. Ground-zero Width, 10-knot Effective Wind

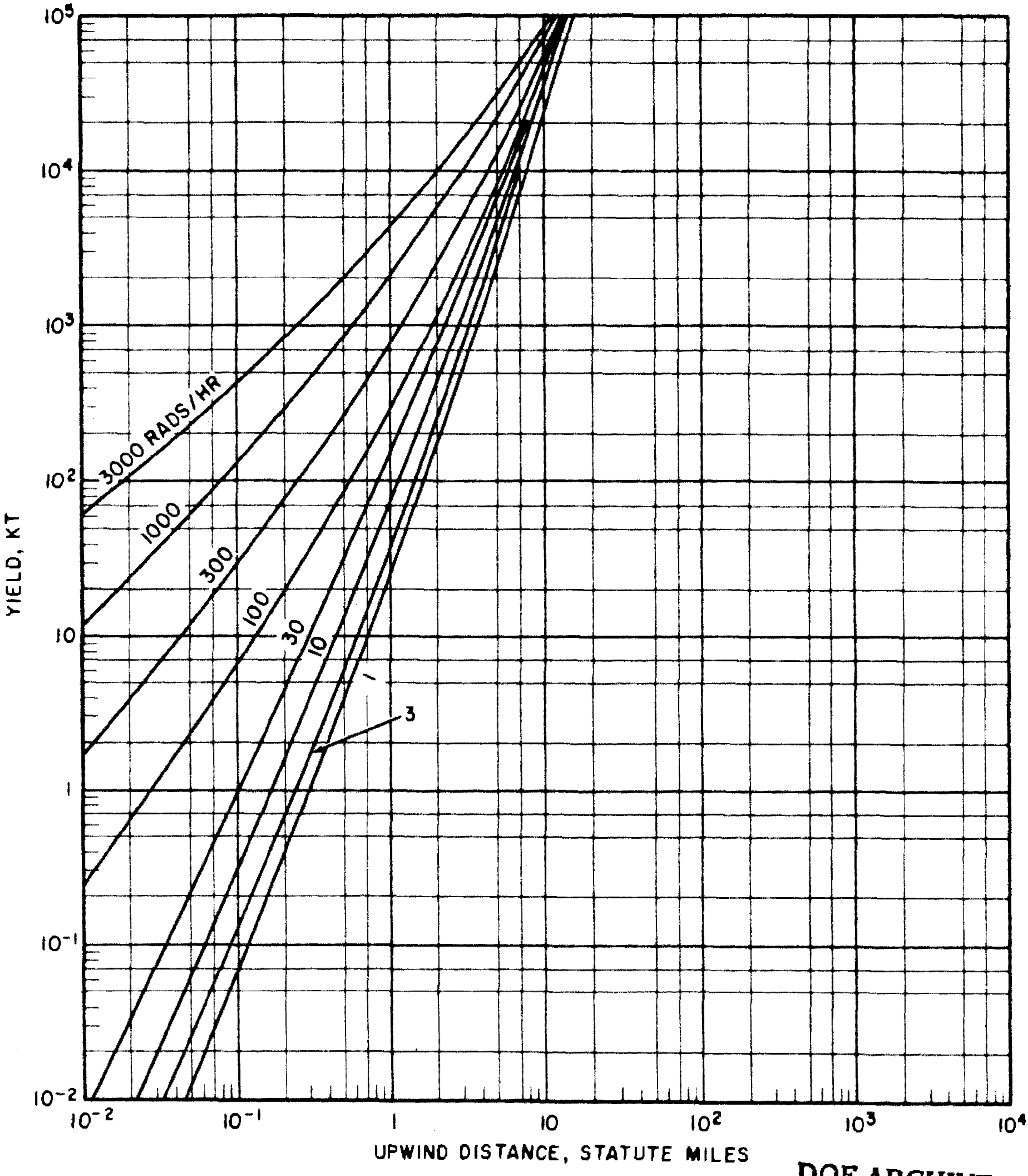

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Figure 4-33. Yield vs. Upwind Distance, 40-knot Effective Wind

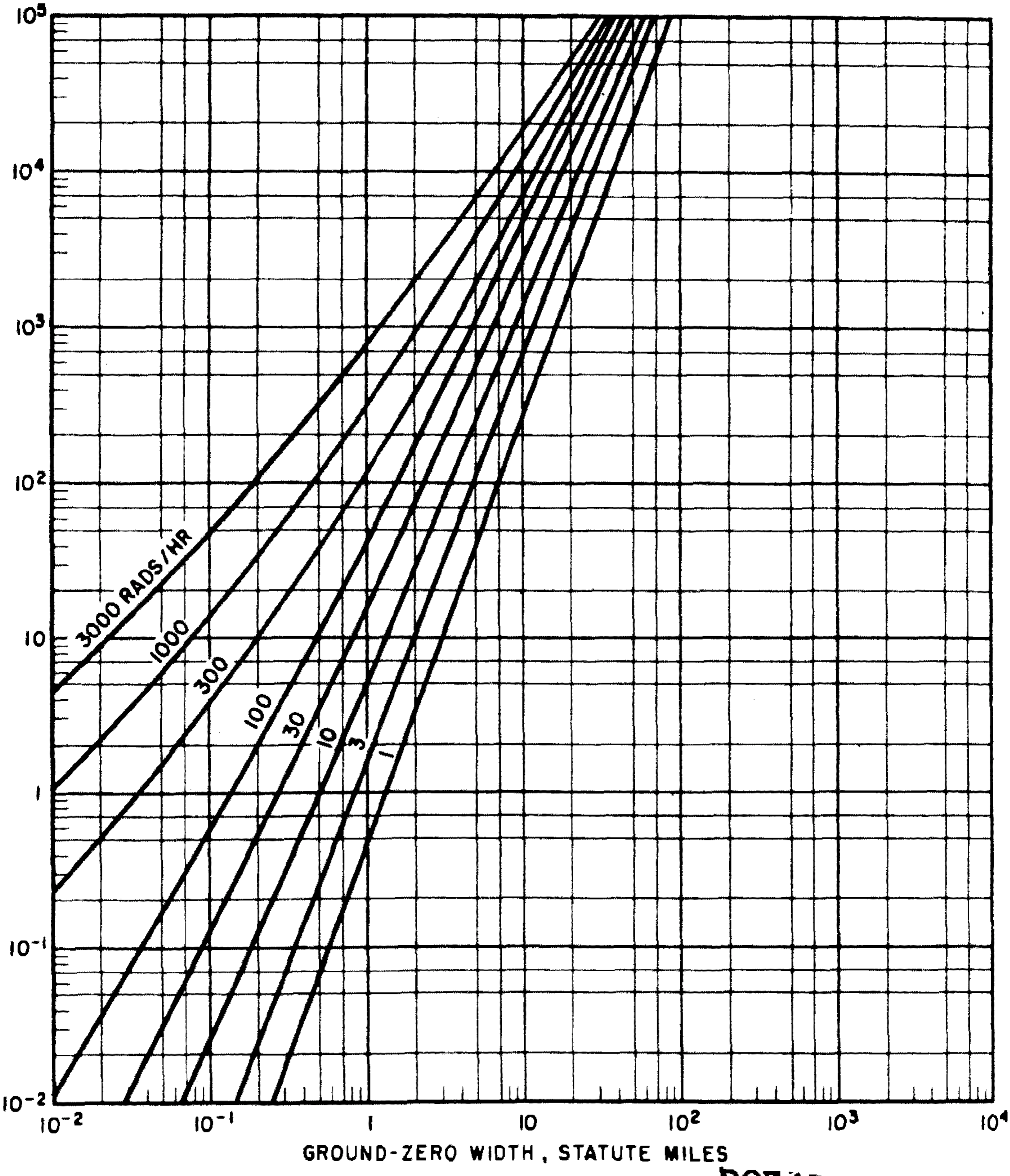

Figure 4-41. Yield vs. Ground-zero Width, 40-knot Effective Wind

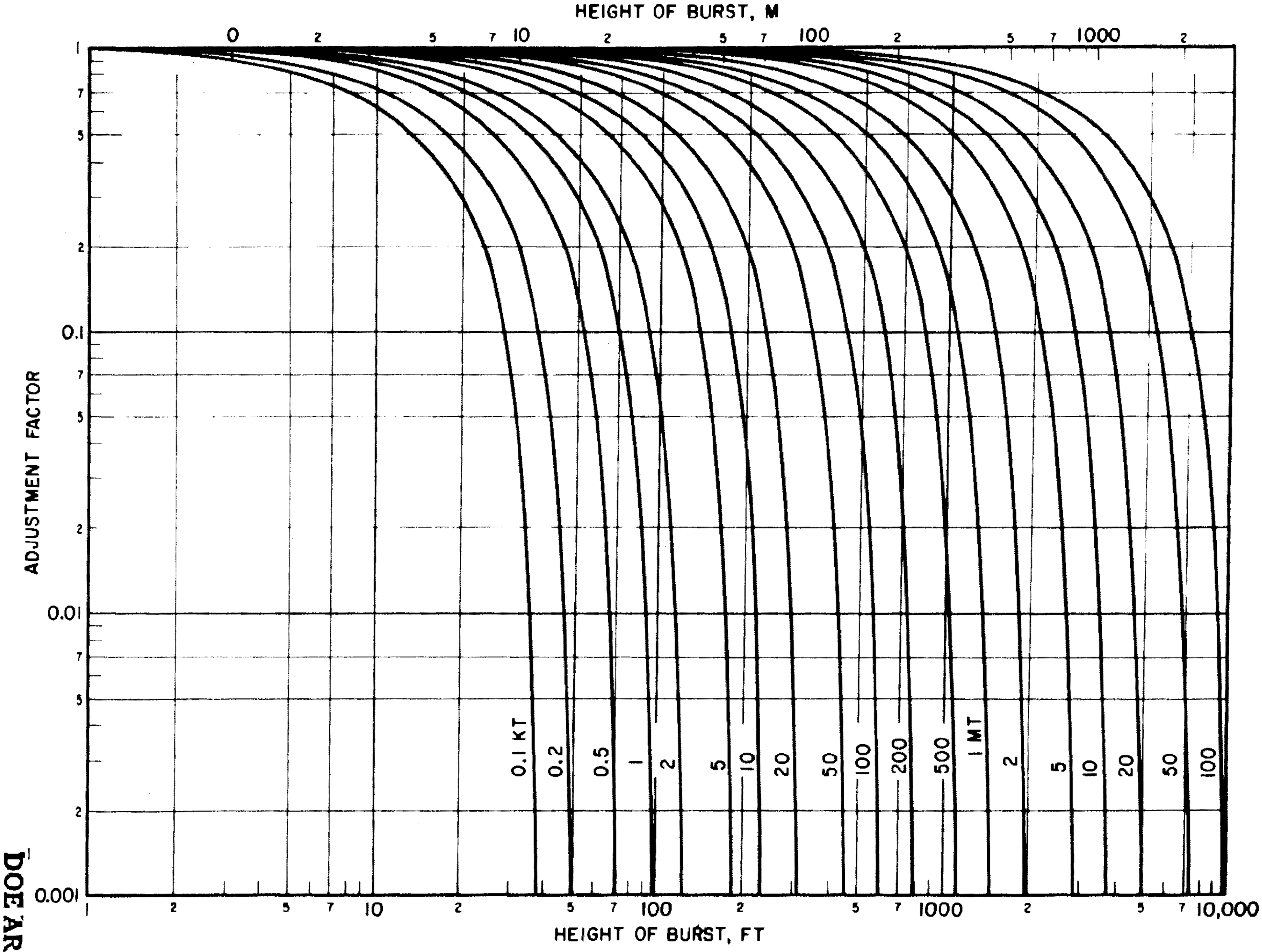

Figure 4-44. Height-of-burst Adjustment Factor for Dose-rate-contour Values Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

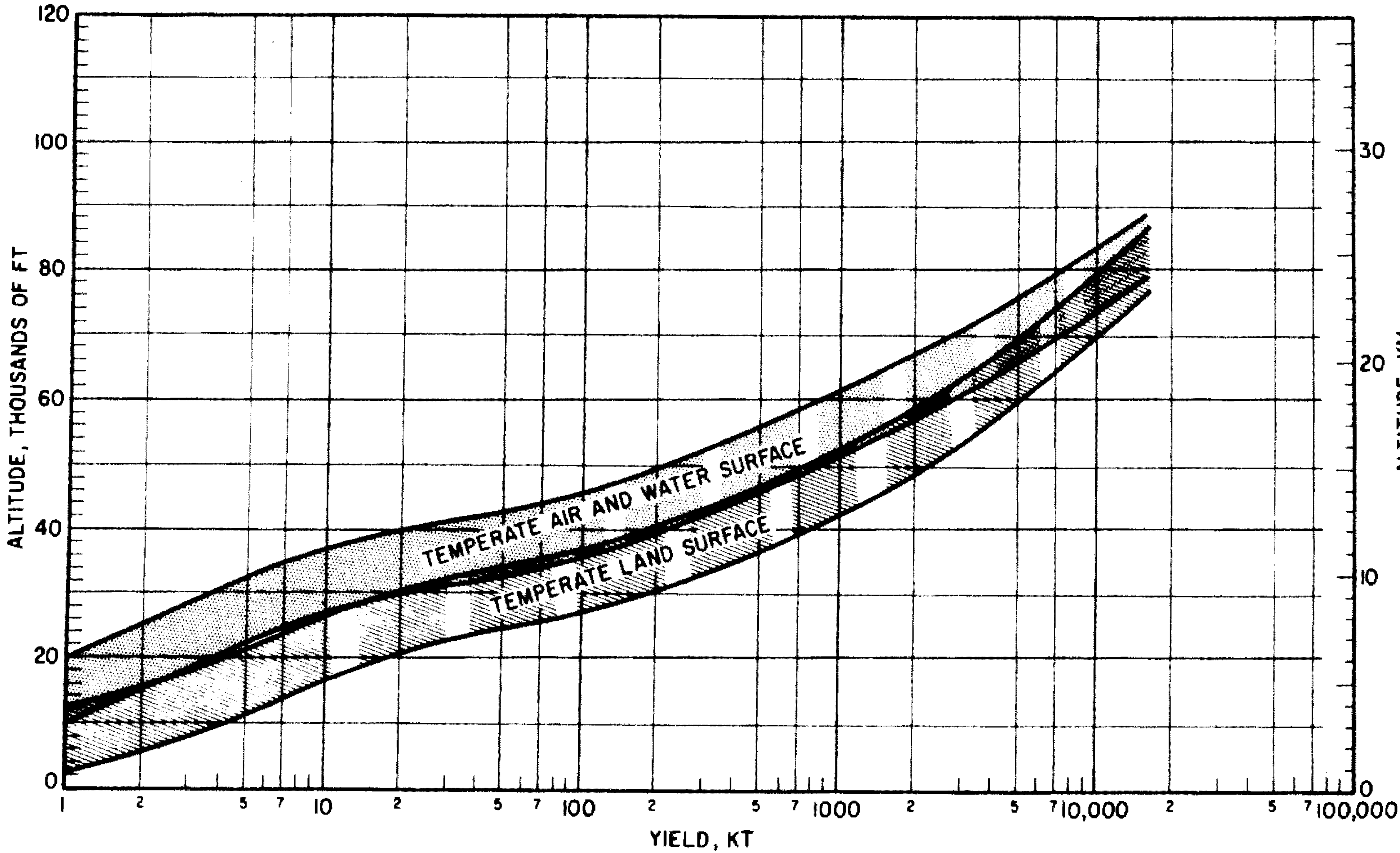

Figure 4-52. Height of Cloud Tops vs. Yield, Temperate Climates

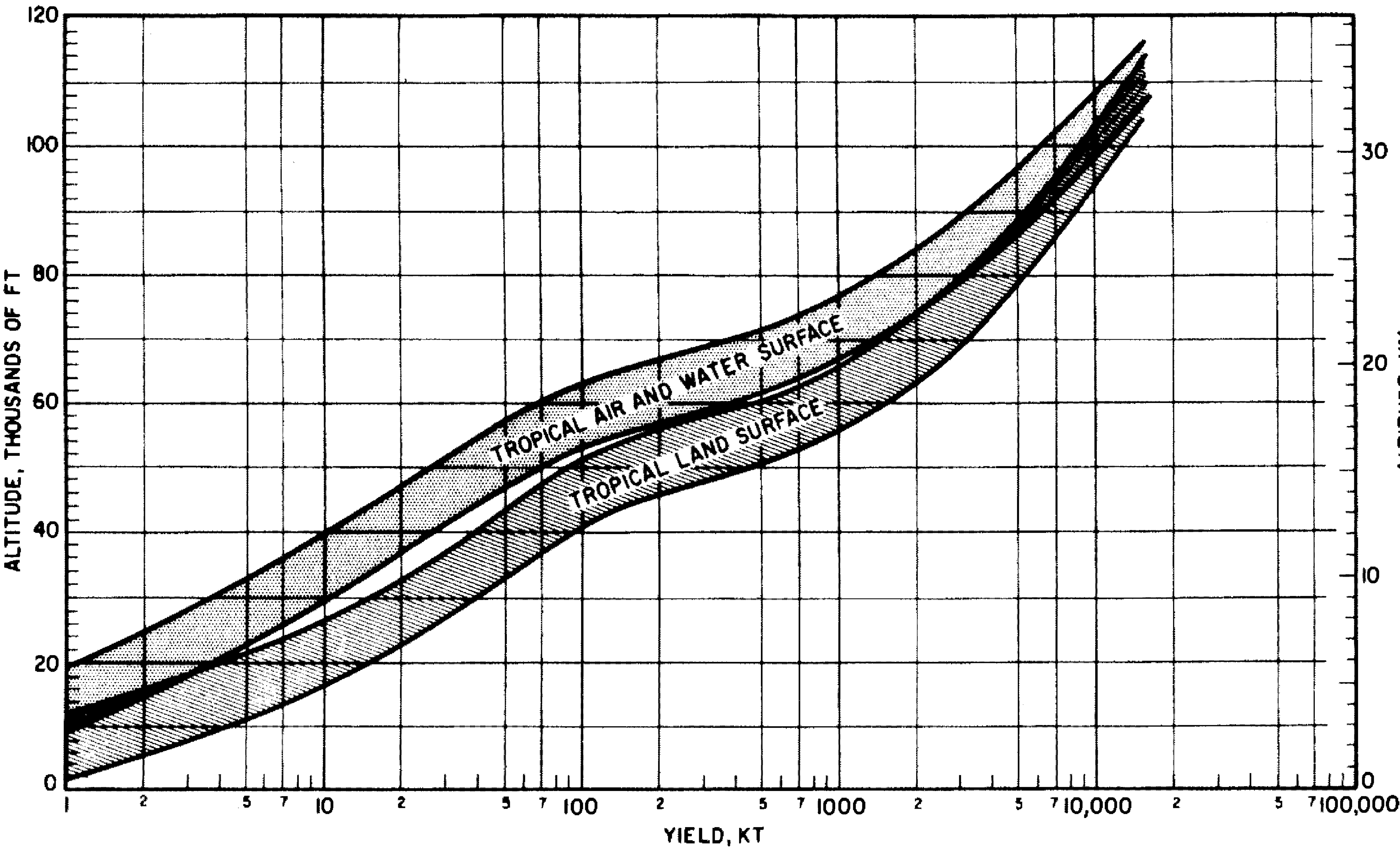

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Figure 4-53. Height of Cloud Tops vs. Yield, Tropical Climates

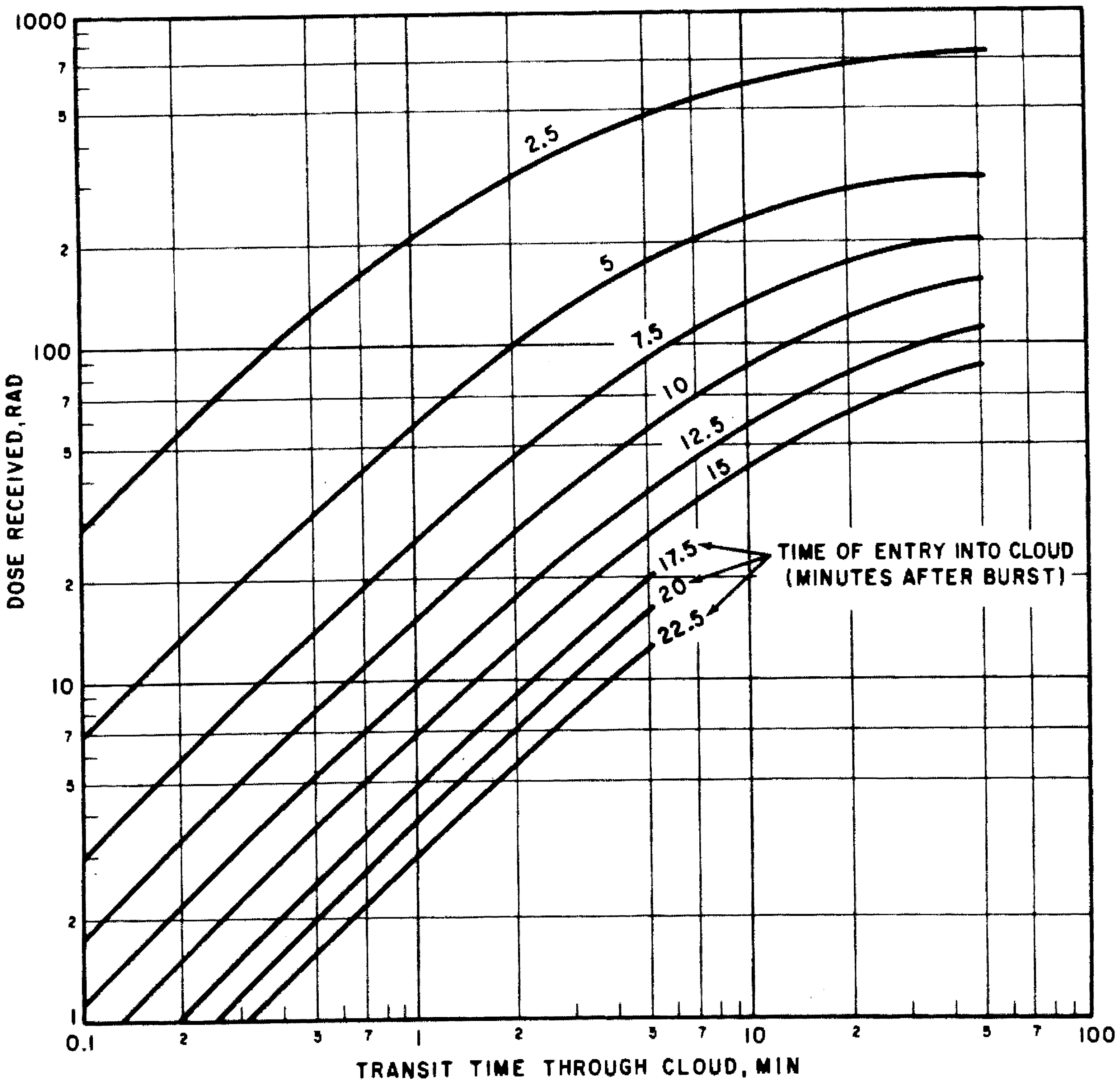

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Figure 4-55. Dose Received While Flying Through a Nuclear Cloud vs. Transit Time Through Cloud

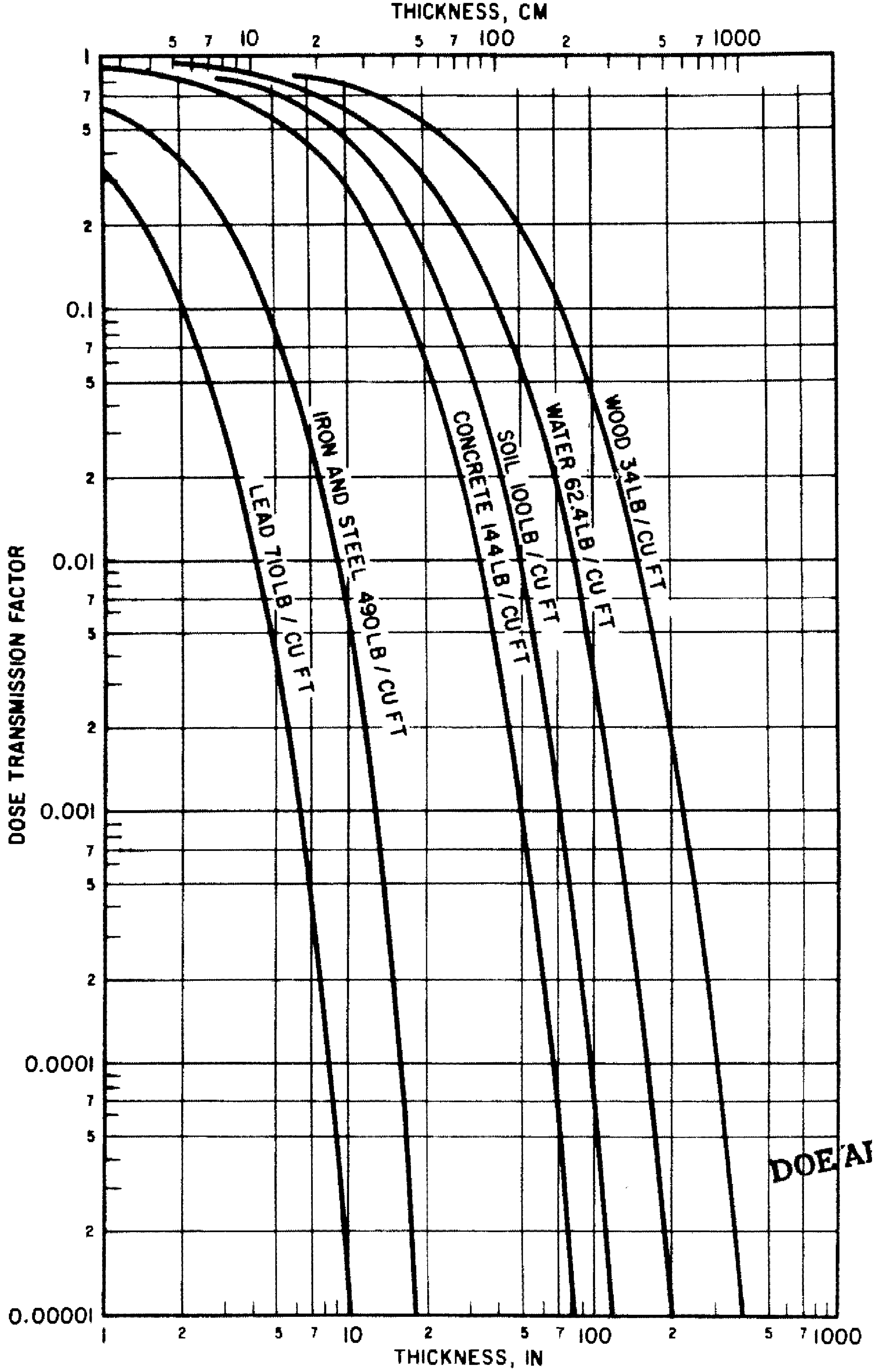

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Figure 7-11. Shielding from Initial Gamma Radiation

Table 4-4 Target-burst Factors (f_{tb}) for Various Ranges of Yield and Locations of Burst and Target With Respect to Surface

Burst and Target Orientation	Air Burst Surface Target	Air Burst Air Target	Surface Burst Air Target	Surface Burst Surface Target	Sub-surface Burst Surface Target
Yield			Target-burst Factors		
Less than 400 kt	1	1.3	0.87	0.667	Obtain dose or ranges directly from figure 4-10
0.4 mt to less than 10 mt	1	1.3	1.3	1	
10 mt to 20 mt	1 (use with air-burst-surface target curves)	1.3 (use with air burst-surface target curves)	1.3 (use with surface burst-surface target curves)	1 (use with surface burst-surface target curves)	
20 mt to 40 mt	1	1.3			

Note: Extrapolation to surface burst conditions for yields greater than 20 mt and to yields above 40 mt for any burst conditions is unreliable.

Burst Location—considered an air burst when height of burst is greater than 1500 $W^{1/3}$ ft.

Target Position—considered an air target when target location is greater than 300 ft above the surface.

[redacted]

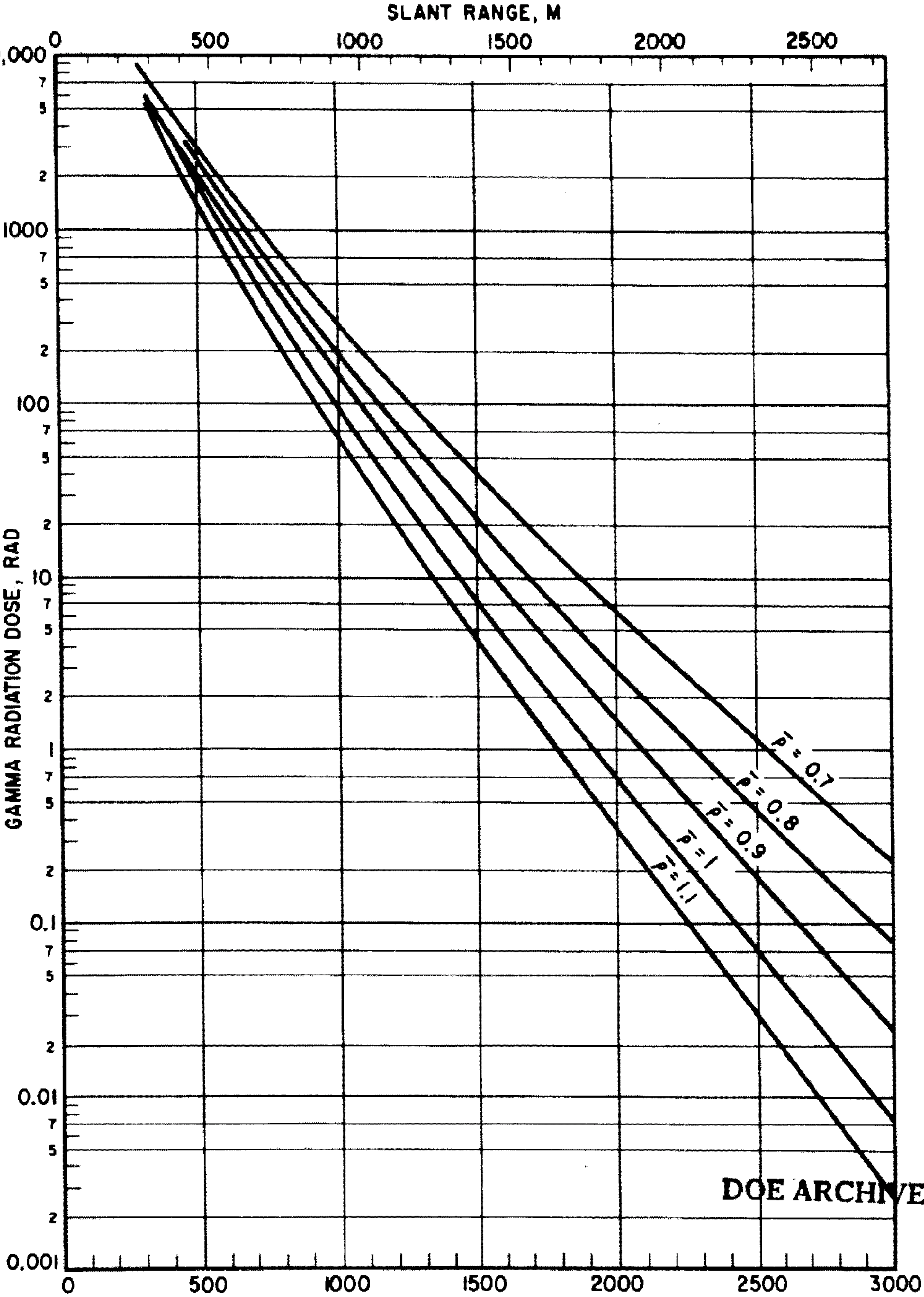

Figure 4-10. Initial Gamma Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-kt Underground Burst, Surface Target Depth 17 ft

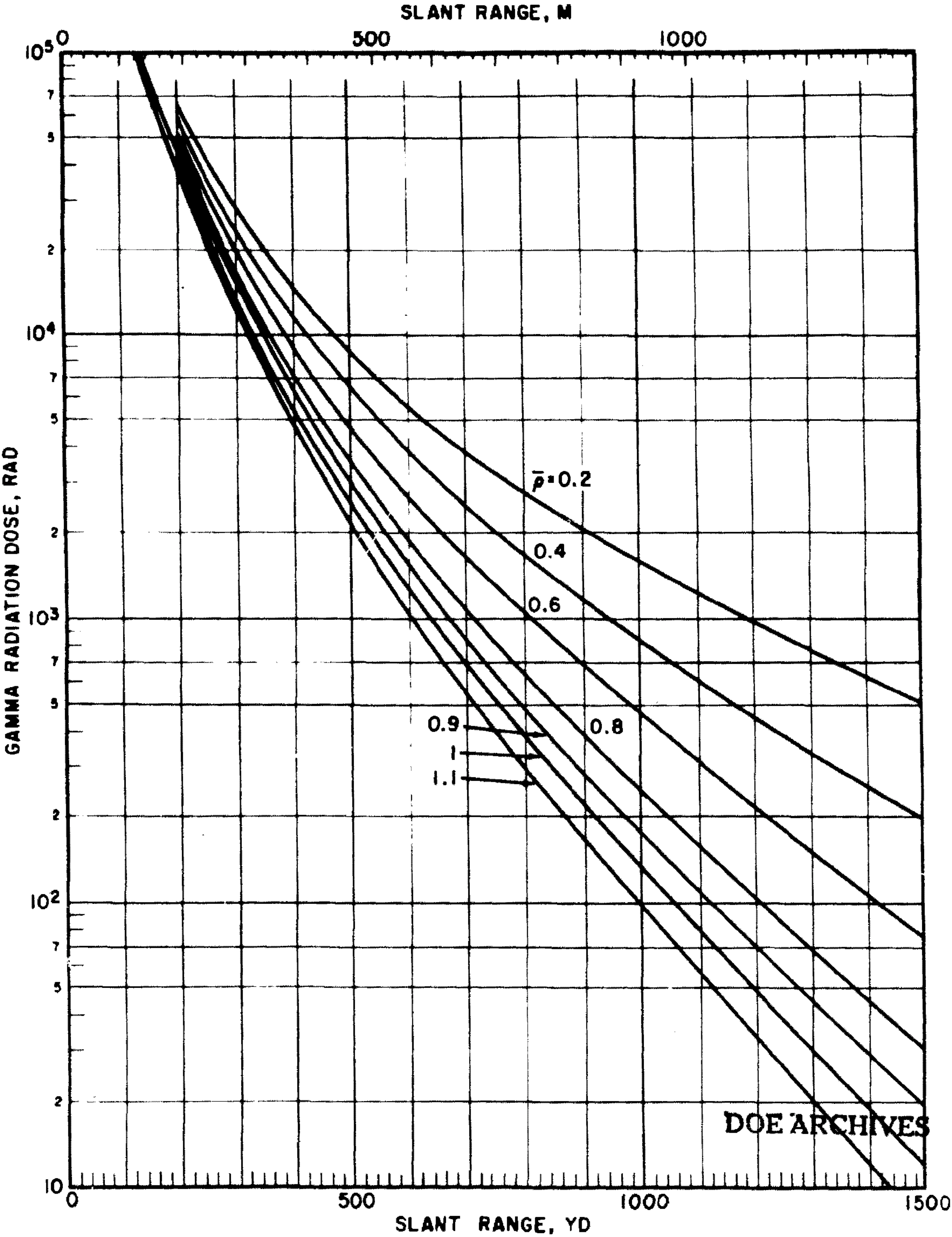

Figure 4-9(A). Initial Gamma Radiation Dose vs. Slant Range (to 1500 yd) for Various Average Relative Air Densities, 1-kt Air Burst-Surface Target

Problem 4-6 Neutron Radiation Dose

Weapon design strongly influences neutron radiation. Figures 4-17 to 4-20 are given as representative curves applicable to four general weapon categories based upon expected neutron output. Figure 4-17 applies to sub-kiloton yields and the dose is given in units of rads/ton. Figures 4-18 and 4-19 apply to average and high-flux kiloton fission weapons respectively, and the units are in rads/kt. Figure 4-20 applies to fusion weapons and the dose is given in units of rads/mt. From these curves the slant range can be determined at which a weapon of given yield will produce a specified dose; conversely, the yield required to produce a given dose at a desired range can also be found.

Several other factors will influence the dose expected at a given target location. If either the target or the burst is raised above the surface the dose can be expected to increase by approximately 50 percent. If the target is located on the water the dose can be expected to be reduced. Figures 4-17 to 4-19, curves for sub-kiloton and kiloton fission weapons, apply directly to the dose received by a land surface target from a low air burst (fireball does not touch the ground). Figure 4-20 applies directly to the dose received by a land surface target from a surface burst.

Table 4-5 Adjustment Factors for Varying Given Conditions

Condition	Factor
Target location on water surface	0.85
Target location airborne	1.5
Changing burst location from air to surface	0.67
Changing burst location from surface to air	1.5

Scaling. At a given range and relative air density, the neutron dose is proportional to weapon yield. For relative air density, see appendix B.

Example 1.

Given: A high flux 50-kt burst at 2000 ft above a water surface where the average air density between the point of burst and the target location is 0.8.

Find: The maximum neutron dose on the surface of the water at a slant range of 2200 yd.

Solution: From figure 4-19 for $\overline{\rho} = 0.8$ the dose for 1 kt at 2200 yd is 2 rads. The correction factor for the target being on water rather than on land is 0.85.

Answer: Therefore the maximum dose on the surface of the water for 50 kt at 2200-yd slant range and $\overline{\rho} = 0.8$ is $2 \times 50 \times 0.85 = 85$ rads.

Example 2.

Given: A sub-kiloton weapon burst on the ground where the relative air density is 0.9.

Find: The yield required to deliver a neutron dose of 450 rads to the outside of a bunker 500 yd from ground zero.

Solution: From the information given, figure 4-17 (sub-kiloton fission) must be used. Because the given conditions for figure 4-17 are air burst-surface target, the adjustment factor "changing burst location from air to surface—0.67" (see table 4-5) must be used to correct for a surface burst.

Answer: From figure 4-17 for $\overline{\rho} = 0.9$ read 7.2 rads/ton at 500 yd, air burst-surface target.

$$7.2 \text{ rads/ton} \times 0.67 \text{ (adjustment factor)} = 4.82 \text{ rads/ton delivered to target}$$

$$\frac{450 \text{ rads total}}{4.82 \text{ rads/ton}} = 92 \text{ tons}$$

Reliability. Depending upon weapon design, it is estimated that the dose values given in figures 4-17 through 4-20 may be low by as much as a factor of 2 for certain very high flux designs and high by as much as a factor of 5 for some older weapon designs.

Related Material. See paragraph 4-6.

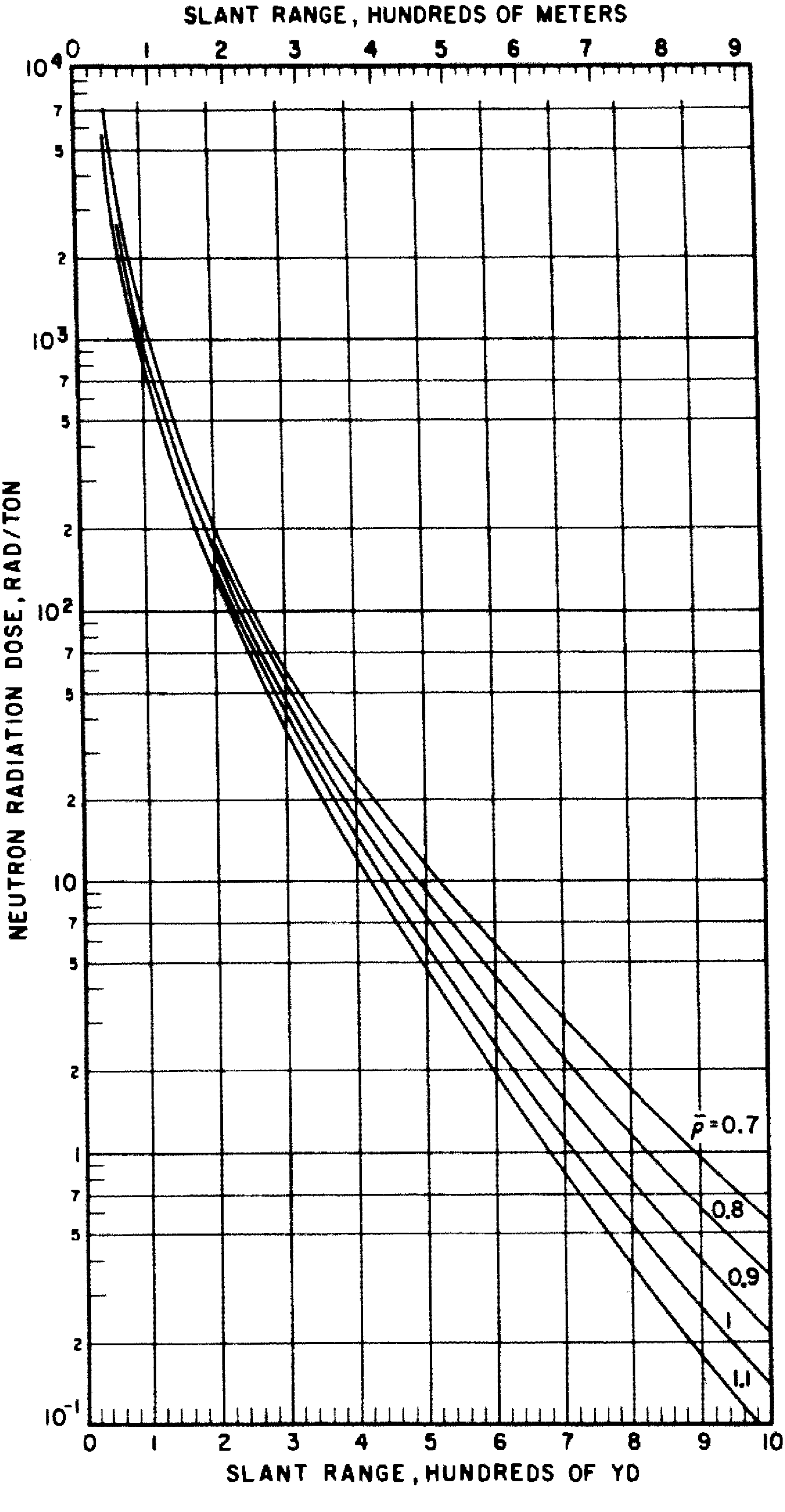

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Figure 4-17. Neutron Radiation Dose vs. Slant Range for Various Average Relative Air Densities, 1-ton (Sub-kiliton Fission) Air Burst-Surface Target

Table 4-1 Chemical Composition of Illustrative Soils

Element	Percentage of soil type (by weight)			
	Type I (Liberia, Africa)	Type II (Nevada desert)	Type III (lava, clay, Hawaii)	Type IV (beach, sand, Pensacola, Florida)
Sodium	—	1.30	0.16	0.001
Manganese	0.008	0.04	2.94	—
Aluminum	7.89	6.90	18.79	0.006
Iron	3.75	2.20	10.64	0.005
Silicon	33.10	32.00	10.23	46.65
Titanium	0.39	0.27	1.26	0.004
Calcium	0.08	2.40	0.45	—
Potassium	—	2.70	0.88	—
Hydrogen	0.39	0.70	0.94	0.001
Boron	—	—	—	0.001
Nitrogen	0.065	—	0.26	—
Sulfur	0.07	0.03	0.26	—
Magnesium	0.05	0.60	0.34	—
Chromium	—	—	0.04	—
Phosphorous	0.008	0.04	0.13	—
Carbon	3.87	—	9.36	—
Oxygen	50.33	50.82	43.32	53.332

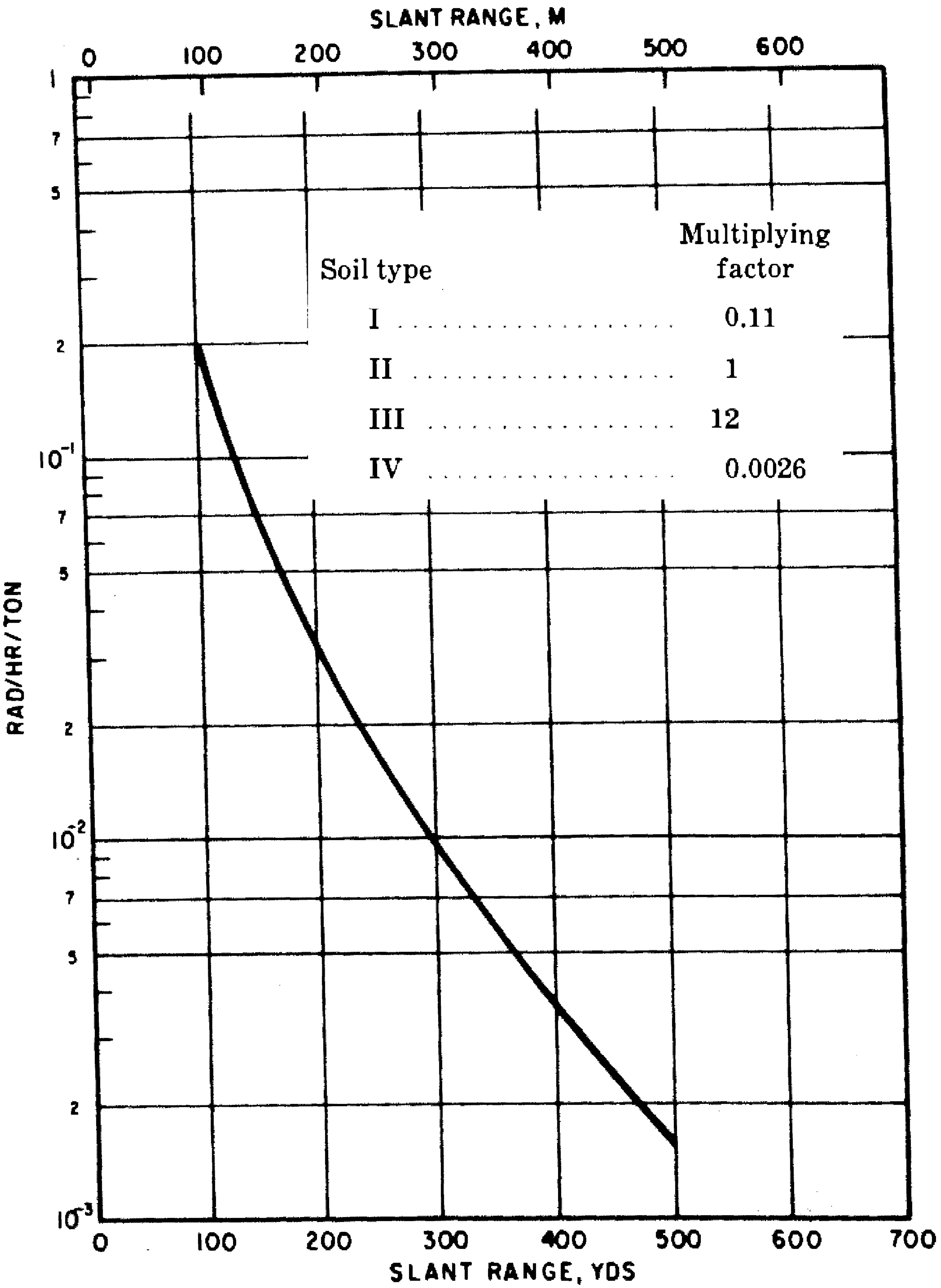

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Figure 4-56. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Sub-kiloton Fission Weapons per Ton

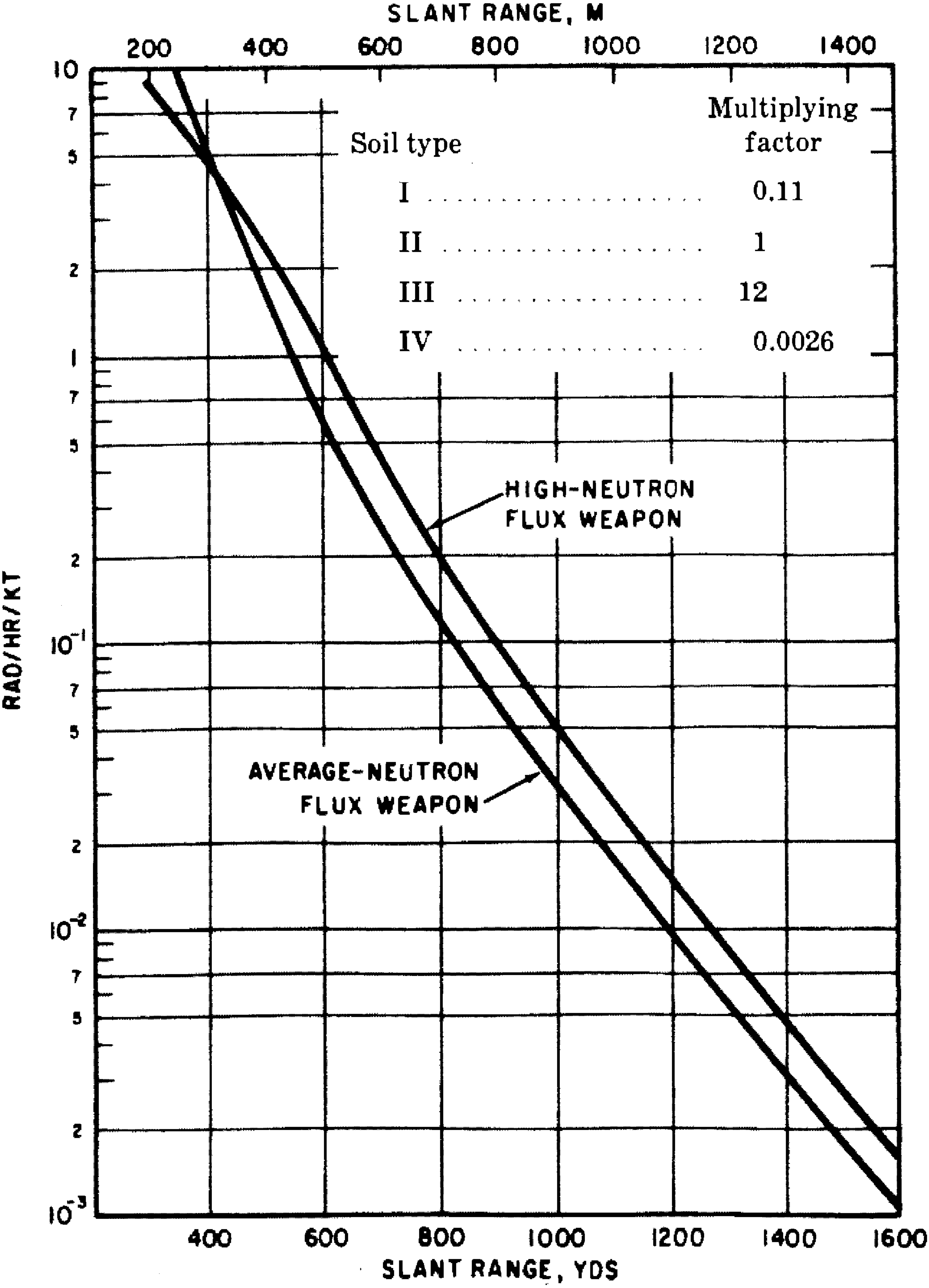


Figure 4-57. Neutron-induced Gamma Activity vs. Slant Range at a Reference Time of 1 hr After Burst, Fission Weapons per kt

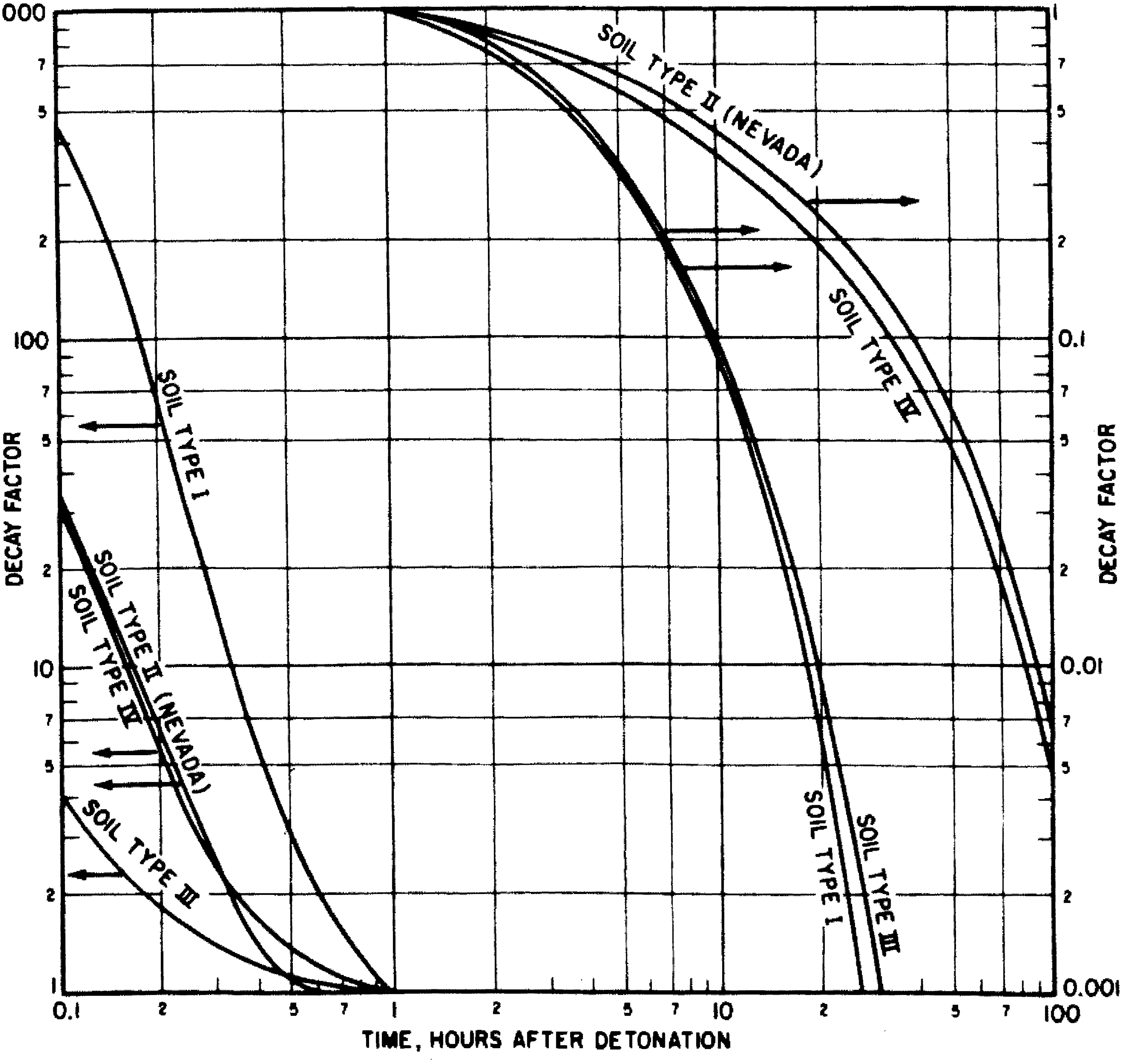


Figure 4-59. Decay Factors for Neutron-induced Gamma Activity

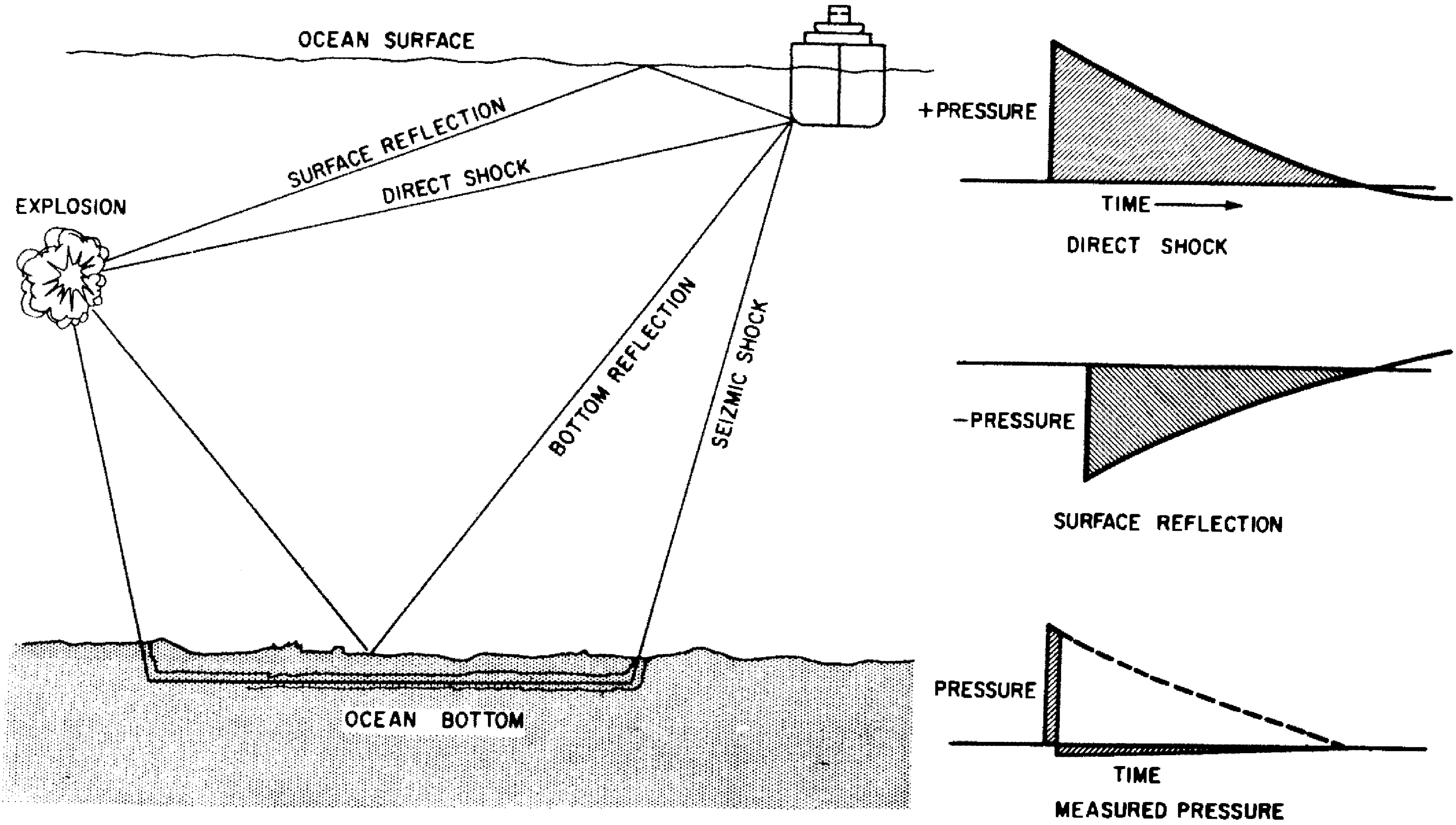


Figure 6-2. Direct and Reflected Shock Waves from an Underwater Burst

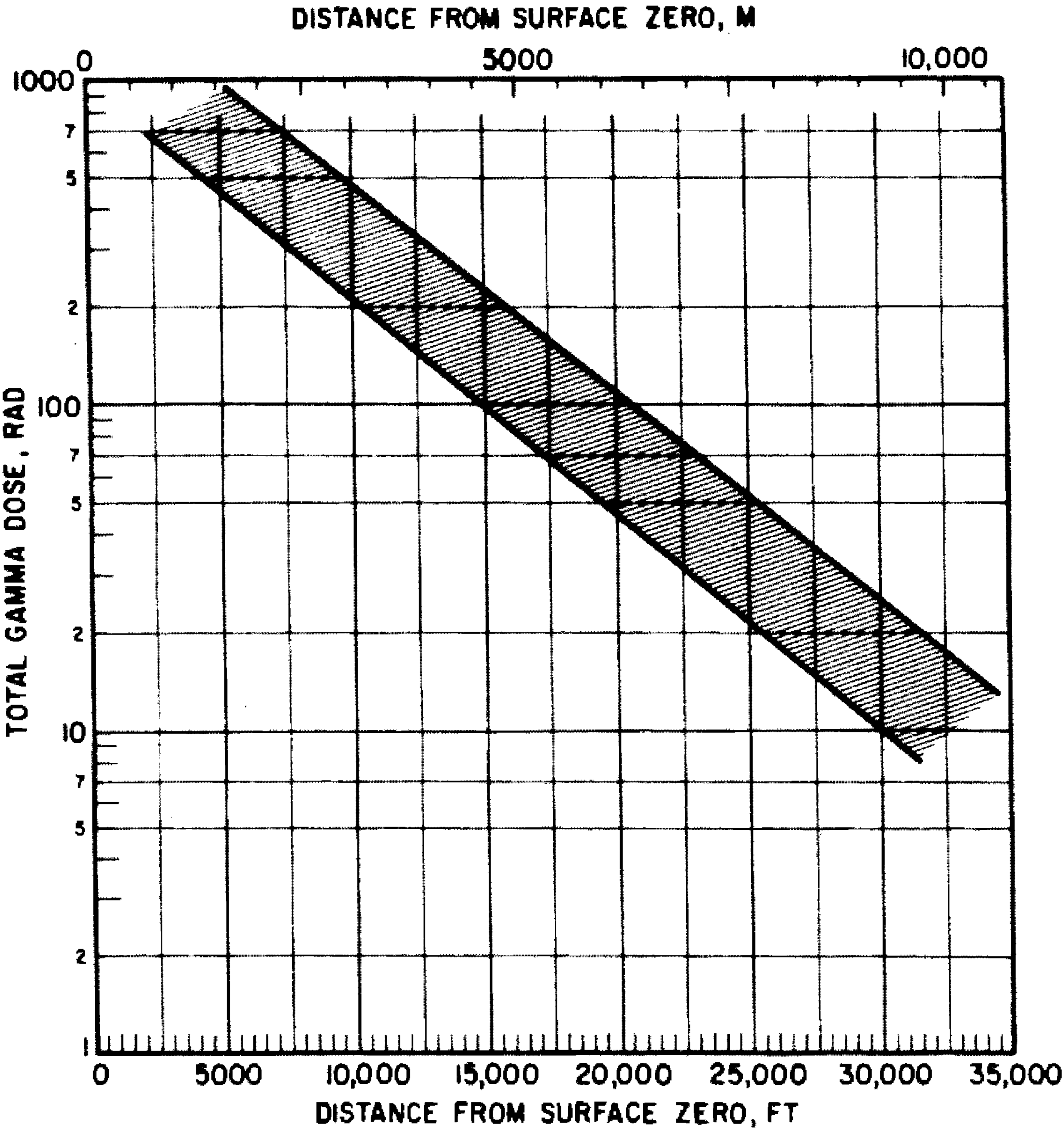


Figure 4-49. Total Dose at the Surface Downwind from a 10-kt Underwater Explosion, 15-knot Wind, Range of Burst Depths, 150 to 1000 ft

some fission products are lost along the path of migration to the surrounding water.

4-28 Fractionation. The radioactive material carried by the base surge, in most cases, fractionates in favor of those fission products having rare-gas ancestors. This probably results from scavenging of the more-refractory fission products by the early subsiding masses of water from the columns of plumes, thereby returning them to the ocean in the immediate vicinity of surface zero.

4-29 Time-space History of the Above-surface Radiation Fields. For all types of underwater explosions, the major source of radiation, to the observer on the surface, is probably the base surge, which can be extremely dangerous to any station it engulfs. Although the total quantity of fission products within the base surge amounts to some 10 to 30 percent of that initially formed, the specific activity is very high because of the early age of the radioactivity. It should be emphasized that *very close* to subsiding columns or plumes, the base surge deposits significant amounts of radioactive material on the surface causing a temporary radiological hazard. The phenomenon is almost entirely transient in nature, similar to being engulfed by a heavy fog.

Evidence to date suggests some distinct differences in the geometry of the base surge depending on whether the explosion is shallow (columns) or deep (plumes). In either case the resulting surge expands radially at a high velocity, and takes the form of a toroid for shallow explosions and is more like concentric multiple toroids for deep explosions. These differences in geometry have two effects on the time-space history of the radiation: as the single toroid passes over a station, the dose rate and dose are delivered in two increments (the forward and rear actions of the ring), as seen in figure 4-6; where concentric multiple toroids are formed, as is the case for the deep explosion, the radiation is delivered over one broad continuous increment, as shown in figure 4-7. The time of passage depends on the maximum extent of the surge periphery, the location of the observer, and the wind speed.

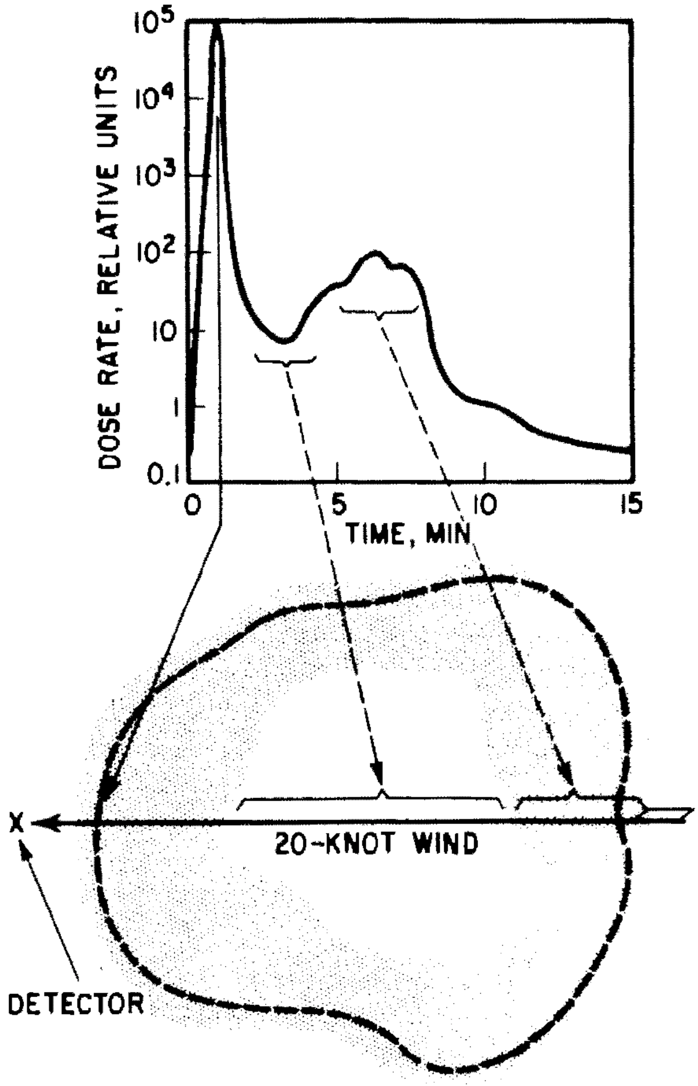


Figure 4-6. Dose Rate vs. Time for a Shallow Underwater Burst

4-30 Water Surface Shot. Nominal-yield bursts on the surface of deep water will resemble the very shallow detonation with the addition of some prompt gamma and neutron activated nitrogen in the atmosphere. For high yields such as a megaton surface burst over shallow water (less than 200 ft deep) the above-surface effects will be similar to those of a land detonation, with the cloud rising to greater heights. Probably, no base surge will develop, but the fallout likely will be different from a land surface burst, and the area of militarily significant fallout will probably be smaller. If the yield is large enough for the cloud to reach the tropopause, the cloud upon reaching this level will rise more slowly and increase in lateral dimensions more rapidly as though flattening out against a ceiling. After reaching maximum altitude, the diameter slowly increases as the cloud drifts downwind. Figure

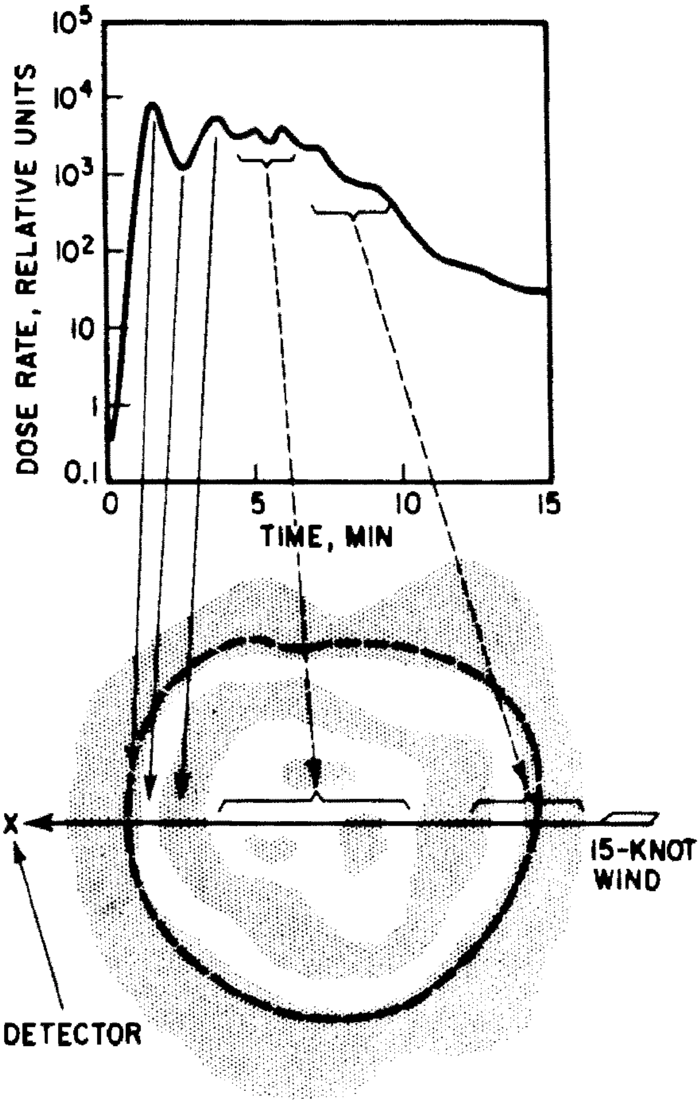


Figure 4-7. Dose Rate vs. Time for a Deep Underwater Burst

4-54 shows the cloud diameter-versus-time relationships. Figure 4-55 gives the dose received by personnel in aircraft flying through an atomic cloud at various times after the detonation.

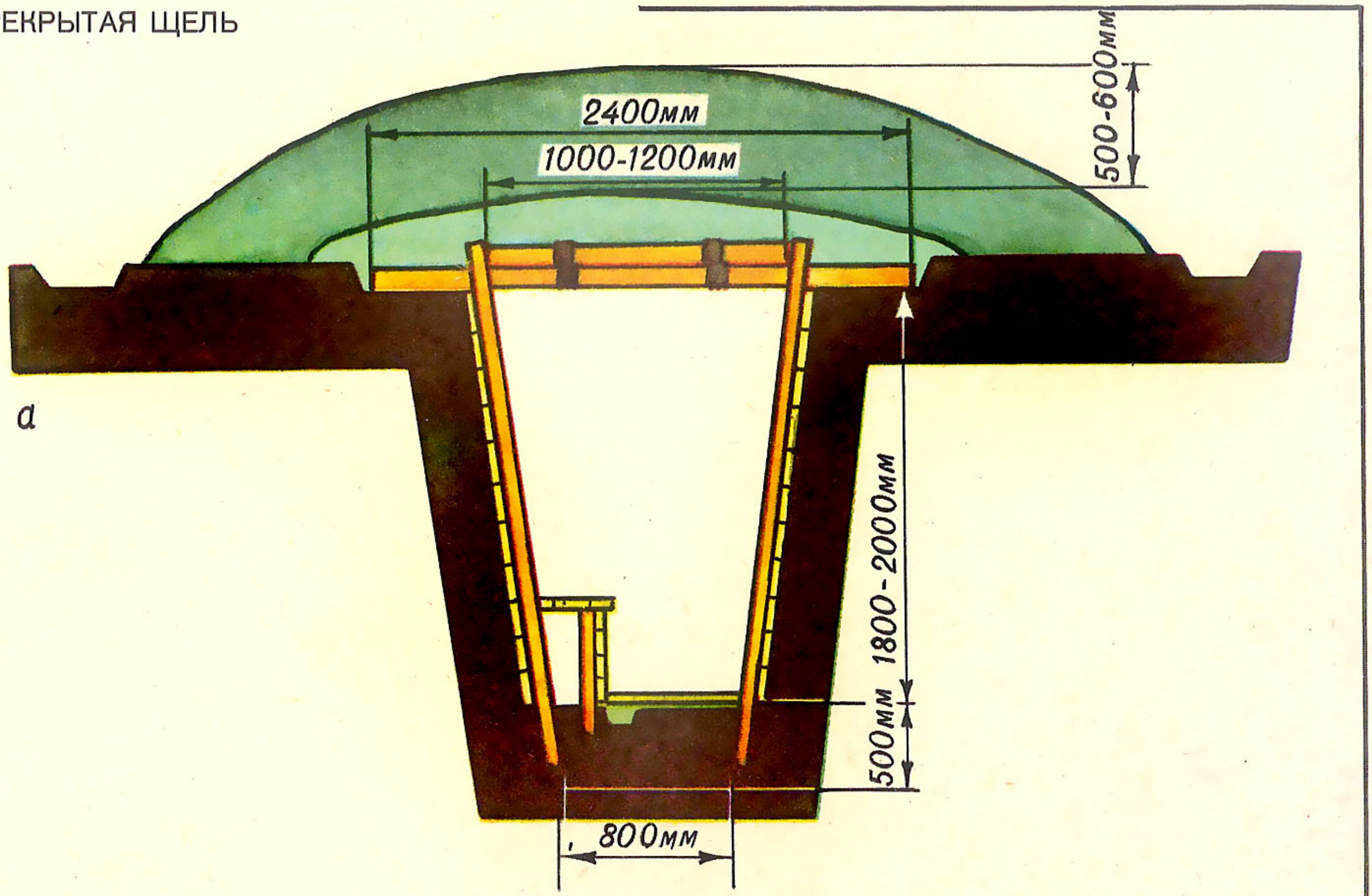
RESIDUAL BETA RADIATION

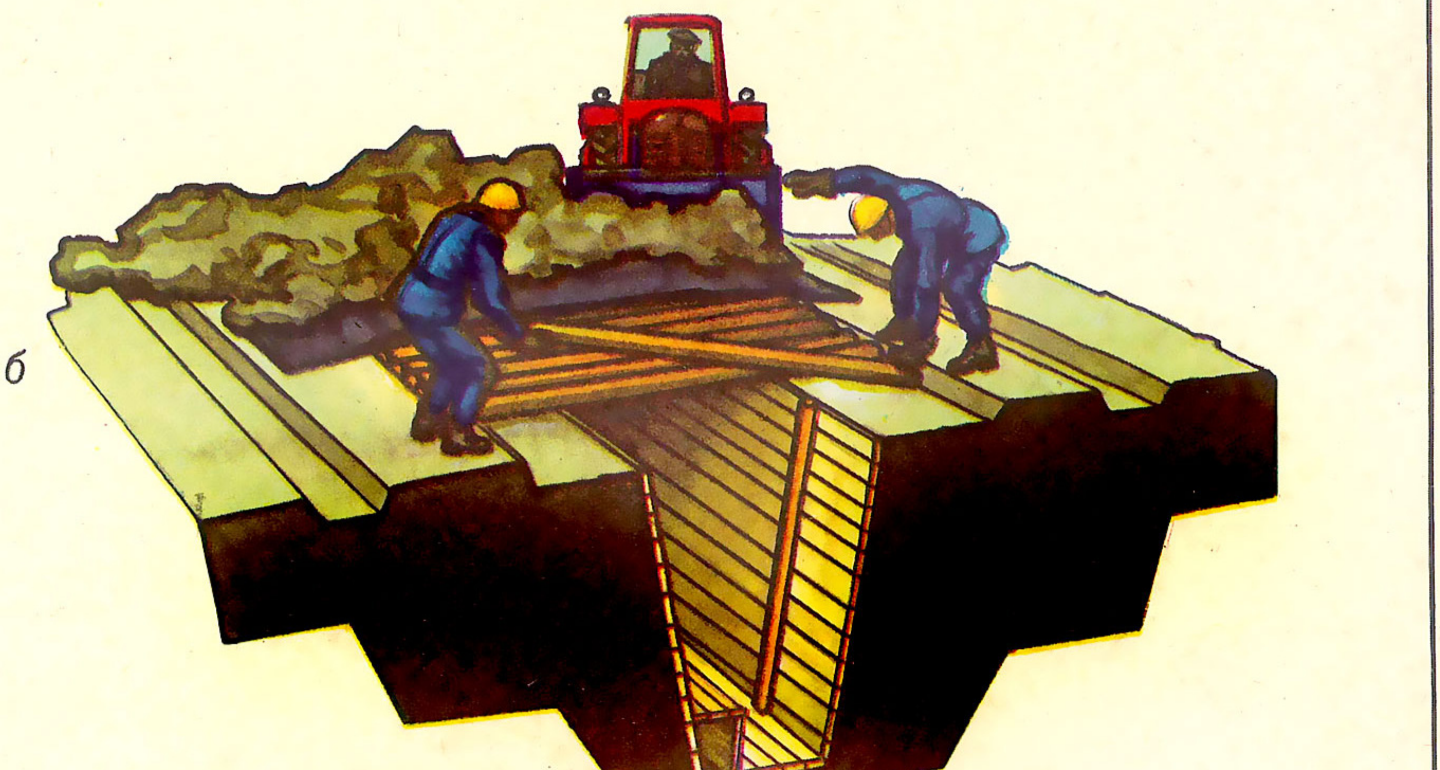
In general, the hazard due to residual gamma radiation exceeds the beta hazard for all cases except those in which intimate contact with beta-active materials occurs, as when an individual lies prone in a contaminated area, or when particles fall out directly upon the skin or scalp. For such cases, superficial burns may result, as discussed in paragraph 7-21.

SHIELDING

The dose rates obtained from the contours described, and the total doses derived therefrom, are free-field values that must be reduced if the individual concerned is protected by some shelter. Shielding factors can be estimated from the considerations stated in paragraphs 7-26 through 7-28. For example, personnel in the open in a built-up city area would receive 0.7 of the free-field dose, whereas personnel in shelter such as the basement of a dwelling would receive about 0.1 of the free-field dose.

ПЕРЕКРЫТАЯ ЩЕЛЬ



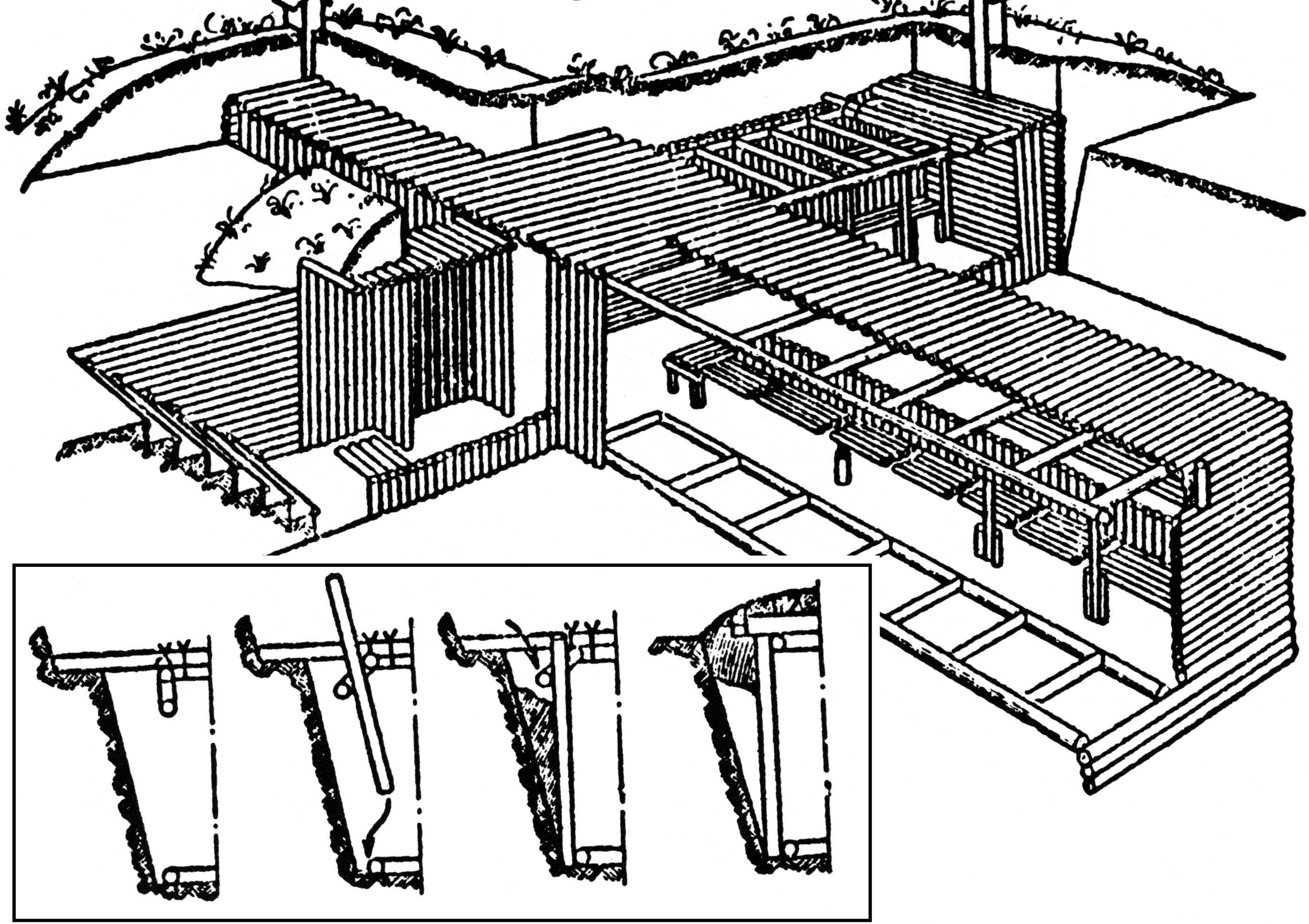


Russian nerve gas atropine injection

Russian civil defence drill

RUSSIAN CIVIL DEFENCE: GAS MASKS, RESCUE TEAMS, BASEMENT SHELTERS AND EVACUATION

Soviet design for pole shelter



MILITARY ASPECTS AND IMPLICATIONS OF NUCLEAR TEST BAN PROPOSALS AND RELATED MATTERS

HEARINGS

BEFORE THE

PREPAREDNESS INVESTIGATING SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES UNITED STATES SENATE

EIGHTY-EIGHTH CONGRESS

FIRST SESSION

PART 1

MAY 7, 15, 28; JUNE 5, 25, 26, 27; AUGUST 1, 2, AND 9, 1963

Printed for the use of the Committee on Armed Services

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which this testing has been done concurrently overseas and within the United States. The first events commenced and completed were underground tests. These consisted of, as you can see here, the Hard Hat event, the Danny Boy shot, and Operation Marshmallow.

In addition, the other four events which occurred at the Nevada test site—The Little Feller II shot—the Danny Boy test, which is a crater and ground shot experiment, the Small Boy test, which comprised a great number of projects which I will go into more detail a little later, and, finally, the Little Feller I shot [deleted].

I will attempt to provide a synopsis of the most significant results of these tests, in terms of the requirements we have previously stated.

The five shots that occurred in the Pacific in the effects area were all high altitude. We did one underwater test which was to evaluate underwater effects for the safe delivery or safe standoff distance for delivery systems in delivering nuclear weapons.

CONTINENTAL TESTS

Test	Purpose	Yield (kilotons)	Date
Underground:			
Hard Hat	Underground structures	5.9	Feb. 15, 1962
Danny Boy	Cratering	.43	Mar. 5, 1962
Marshmallow	[Deleted]	[Deleted]	June 28, 1962
Atmospheric:			
Little Feller II	[Deleted] effects	[Deleted]	July 7, 1962
Johnie Boy	Cratering	.5	July 11, 1962
Small Boy	[Deleted]	[Deleted]	July 14, 1962
Little Feller I	[Deleted] effects	[Deleted]	July 17, 1962

PACIFIC TESTS

Test	Purpose	Yield (kilotons)	Date
High altitude:			
Star Fish	400 kilometer effects	1,450	July 9, 1962
Check Mate	[Deleted] effects	[Deleted]	Oct. 20, 1962
Blue Gill	[Deleted] effects	[Deleted]	Oct. 26, 1962
King Fish	[Deleted] effects	[Deleted]	Nov. 1, 1962
Tight Rope	[Deleted] effects	[Deleted]	Nov. 4, 1962
Underwater: Sword Fish	Underwater effects	13.5 CLASSIFIED IN 2015!	May 11, 1962

DEFINITION OF HIGH ALTITUDE

Senator SALTONSTALL. High altitude is about how high?

Colonel CLINTON. We usually think of high altitude being anything above the altitude normally associated with airplane flight, sir.

Most of our high-altitude shots have been from 20 kilometers on up. We have done some lower altitude shots that have been in the atmosphere, which we have done by balloons. We generally think of high-altitude tests as being those tests above manned aircraft.

Senator THURMOND. What elevation is that, Colonel?

Colonel CLINTON. Fifty thousand feet, sir, on down. Normally I would say we would think of anything above 50,000 feet—I believe we would consider that a high-altitude shot.

Senator STENNIS. All right, proceed.

Colonel CLINTON. I will attempt to discuss some of the results which we obtained from the tests in the last series.

The first of these is the vulnerability of hardened sites to both blast and shock effects [deleted]. These are the [deleted] major phenomena to which are hardened sites [deleted] are vulnerable. [Deleted]

Yesterday, as you know, we had Admiral Anderson before us. He presented the statement that represents the joint views of the members of the Joint Chiefs.

I nevertheless think that it is important for you to testify personally in addition thereto.

You refer to the views expressed in the joint statement, and you concurred in that statement, is that right?

TESTIMONY OF GEN. CURTIS E. LeMAY, CHIEF OF STAFF, U.S. AIR FORCE; COL. OLA P. THORNE, ASSISTANT FOR NUCLEAR ENERGY TO THE DEPUTY CHIEF OF STAFF, RESEARCH AND DEVELOPMENT, U.S. AIR FORCE; FRANK H. PEREZ, CONSULTANT ON ATOMIC ENERGY MATTERS TO THE ASSISTANT CHIEF OF STAFF, INTELLIGENCE, U.S. AIR FORCE, ALSO AIR FORCE MEMBER OF THE JOINT ATOMIC ENERGY INTELLIGENCE COMMITTEE; AND LT. COL. CHESTER A. SKELTON, ARMS POLICY BRANCH, DEPUTY CHIEF OF STAFF, PLANS AND OPERATIONS, U.S. AIR FORCE

General LEMAY. Yes, sir; that is right.

Senator STENNIS. You have filed a very strong supplementary statement. I believe it will expedite the matter if we can let the general read his statement now and read it in its entirety. Then we can ask questions.

All right, General, will you proceed in your own way?

LE MAY STATEMENT

General LEMAY. Mr. Chairman and members of the committee, the views of the members of the Joint Chiefs of Staff on a proposed nuclear test ban treaty were presented by Admiral Anderson on June 26, 1963. The agreed joint statement was submitted for the record .

I shall not elaborate further on the views presented in the agreed statement. However, I should like to repeat for emphasis that it is the judgment of the Joint Chiefs of Staff that the proposed test ban treaty is not adequate to prevent the Soviet Union from making important advances in nuclear weaponry [deleted]. We have concluded that the proposed treaty is not consistent with the national security.

At this time I should like the opportunity to discuss with you my views on the military implications of a nuclear test ban. [Deleted.]

If we expect to maintain military superiority, as the situation exists today, we must do two things: (1) continue to expand our understanding of weapon effects, and (2) continue to improve our military capabilities through the development and application of new weapon techniques. Nuclear testing is necessary for both of these objectives. To put it in another way: continuing, substantial progress in our nuclear technology is essential if we are to maintain the military capability necessary to support our overall foreign policy objectives. Testing is essential for such progress.

Some advance in nuclear technology can be made without testing, but the rate is unacceptably slow. This fact was brought home to us solidly by the 1958, self-imposed moratorium. We attempted to maintain our laboratories at a readiness-to-test capability; and we dis-

At sea level, the radiation dose from cosmic radiation far exceeds that from fallout; at higher elevations (Denver, Colo., 5,000 feet), cosmic radiation contributes an even greater fraction of the total body dose.

Fear of the unknown is played up by cartoons, propaganda, half-truths and misinformation as to the effects of fallout. I do not wish to imply that fallout cannot be a hazard; however, with proper precautions, such as those taken by the AEC, the hazard is minimized. A good public information program could allay most of the present concern. It is clear that effects from fallout are far less dangerous to our people, and the people of the free world, than the risks of Russian predominance in the nuclear weapons field.

Unless we are willing to undertake our testing program enthusiastically, and to expend the necessary effort and resources to insure a positive U.S. superiority in all of the critical nuclear areas, the Soviets stand to gain a clear margin of nuclear superiority vis-a-vis the United States. In the current world environment, preserving peace means maintaining preponderant military power. To maintain a favorable balance of military power we must have nuclear superiority. To do this I firmly believe we must continue our nuclear weapon development programs and be able to conduct nuclear testing as required.

WHETHER TESTING IS NECESSARY TO MAINTAIN U.S. SUPERIORITY

Senator STENNIS. General, may I ask a few questions now based on your supplemental statement?

In the first part of your statement you say, and I am paraphrasing, that testing is essential for progress; and testing is also necessary to maintain our military superiority.

Now my question is this: Is this still true even if Russia should, under agreement, actually stop testing?

Suppose there should be a treaty and it should be observed and Russia actually stopped testing. Would our position then become inferior? Would parity result or would your statement hold true if there should be agreement?

General LEMAY. If both sides agreed to stop testing now, and the Russians abided by the agreement, they would certainly be ahead of us in the high-yield weapons. We are sure of that.

They are probably ahead of us in the [deleted] range. [Deleted.]

While there seems to be general agreement [deleted] that we are probably still ahead in the low-yield range, I am not so sure that we have enough information to support this view.

It seems to me that at the time the Soviets decided to go ahead with their very comprehensive test program, they probably planned to test across the spectrum. They may have concentrated on high-yield tests; however, I believe it is prudent to assume that they went clear across the spectrum of yields. [Deleted.]

Senator STENNIS. So, regardless of the situation at the lower yields, you feel sure that from [deleted] upward they have a present superiority which, of course, they would maintain if all testing were stopped by both sides, is that correct?

General LEMAY. I think that is correct; yes, sir.

TOP SECRET

B.F. with other Min
11/3

R. 5th March, 1953.

Dear Montague-Browne,

With reference to my letter of 4th March about the article in the Daily Telegraph on searching of ships for atomic bombs, my attention has now been called to the fact that Sir Norman Brook sent a minute to the Prime Minister on this subject dated 28th March 1952, enclosing a copy of a paper headed "Clandestine Use of Atomic Weapons".

I had not realised when I wrote to you that Sir Norman Brook had been handling this question. I suggest that in the circumstances it would be better not to put my letter to the Prime Minister until Brook has had an opportunity of considering the matter further in the light of recent developments. I will let you know as soon as I can whether or not we would like the letter to go forward.

Yours sincerely,

[signature]

Sir N. Brook's minute now submitted.

AMB
10/3

A.A.D. Montague-Browne, Esq., D.F.C.

TOP SECRET

PRIME MINISTER

You have drawn the attention of the Ministry of Defence to an article about Atom Bomb Checks by American Coast Guards, which appeared in the Daily Telegraph on February 27. — flag 'A'

flag 'B'

I made a submission to you on this subject on March 28, 1952, when I sent you a copy of a minute which I had sent to Mr. Attlee in July, 1951. I said then that I believed the risk that an enemy might explode an atomic bomb in a ship in one of our ports was one against which we could not at present take any effective precautions. Recently, however, we have heard that the Belgians and the Dutch - as well as the Americans - are claiming to have introduced precautions of some sort. We are now finding out more about these; and, when this information is available, I will make a further submission to you on the question whether we should review our own position again.

Duplicate noted and returned.

12/3.

MARCH 9, 1953

R.

12.3

Norman Brook.

EXTRACT FROM "THE DAILY TELEGRAPH"

27/2/53. page 7:

ATOM BOMB CHECKS
1,500 Ships Searched

Rear-Adml. Richmond, Assistant Commandant of the Coast Guard Service, revealed to-day that Coast Guards were regularly searching vessels approaching ports such as New York for atomic bombs, other types of explosive and bacteriological weapons. More than 1,500 ships had been searched during the past two years.

At present 30-40 vessels are being searched monthly, most of them from Iron Curtain countries. "So far," added the Admiral, "we have found nothing that resembled explosive."

G.R. **TOP SECRET**

Tube Alloys
Clandestine use of weapons
Part 2

PRIME MINISTER

At the "Apex" Committee on Wednesday you asked me to let you have a report on the risk that an enemy might explode an atomic bomb in a ship in one of our ports and on difficulties of countering this risk.

I attach the report below on this question which I submitted to Mr. Attlee in July, 1951. As you will see, the Chiefs of Staff had then asked me to arrange to have the matter further considered by the civil Departments concerned; but I had come to the conclusion that matters could not be advanced further by this means and I suggested that Mr. Attlee should discuss the problem with the Foreign Secretary and the Minister of Defence. This he was unable to do before the Election. Since then I have taken no further initiative to raise the matter since I myself believe that this is a risk against which we cannot at present take, in normal times, any effective precautions.

Norman Brook.

R. 28th March, 1952

TOP SECRET

PRIME MINISTER

Clandestine Use of Atomic Weapons

The Chiefs of Staff have been considering the possibility that the enemy might open the next war with an atomic attack on London on the model of the Japanese attack on Pearl Harbour - without warning and before any formal declaration of hostilities. The most effective method of making such an attack would be to drop an atomic bomb from a military aircraft. If the control and reporting system were fully manned and alert in a period of tension, there would be some chance that hostile aircraft approaching this country could be intercepted and driven off. At any rate, there are no special measures, outside the normal measures of air defence, which we could take in peace-time to guard against this type of attack.

2. It is, however, possible that the enemy might use other means of surprise attack with atomic weapons. A clandestine attack could be made in either of the following ways:-

(i) A complete atomic bomb could be concealed in the hold of a merchant ship coming from the Soviet Union or a satellite country to a port in the United Kingdom:

(ii) An atomic bomb might be broken down into a number of parts and introduced into this country in about fifty small packages of moderate weight. None of these packages could be detected by instruments as containing anything dangerous or explosive, and even visual inspection of the contents of the packages would not make identification certain. These packages could be introduced either as ordinary merchandise from Soviet ships, or possibly as diplomatic freight. The bomb could subsequently be assembled in any premises with the sort of equipment usual in a small garage, provided that a small team of skilled fitters was available to do the job.

3. It is difficult at any time to take practical and effective measures against this type of danger. It would be less difficult, of course, in a period immediately before the outbreak of a war which the

public had come to regard as inevitable - the period which we call the Precautionary Stage. But the enemy might prefer to make such a move in a period of comparative calm, when he might assume that less attention would be paid to security risks of this kind.

The only possible measures which could be taken to reduce this risk are control of shipping and closer supervision of diplomatic freight.

Control of Shipping

4. For effective security against this risk all suspect shipping would have to be kept at least 5,000 yards distant from any worth-while target - e.g. from London, Liverpool, Glasgow, Southampton, Bristol and Hull. There are in theory four possible ways of doing this:-

(a) Trade Attraction. All Russian ships carrying bulk cargoes on Government account could be diverted to minor ports, by specifying that that was where the consignee desired delivery of the goods. This would be regarded as discrimination against Russian ships and would invite inconvenient reprisals. It would be expensive. And it would not cover Russian ships carrying cargo ordered on private account.

(b) Diversion by Order. The Admiralty could take power to regulate the movements of all vessels, as they had in the war under Defence Regulation 43. They could then divert all ships of any kind suspected of carrying Russian cargo to minor ports. By a liberal use of this power, the diversion could be made effective; but the discrimination against Russian and satellite shipping would be so blatant that it might well end in the complete stoppage of all trade with the Iron Curtain countries.

(c) Off-shore Discharge. All Russian, Polish and Roumanian ships approaching the major ports could be instructed to discharge their cargoes at off-shore anchorages. This method would lead to retaliation. Moreover, it is hardly practicable; for grain is the main commodity carried by Russian ships and we do not possess the floating elevators which would be necessary for off-shore discharge of grain cargoes at all major ports.

(d) Port and Transit Control. In the Precautionary Stage we propose to introduce a scheme by which all ships approaching the country would be met and escorted to determined ports and anchorages. Under this control

suspect ships could be diverted away from the main target areas; but the control would only be practicable in the Precautionary Stage when there would be a much reduced volume of United Kingdom and Allied shipping, and enemy shipping would be likely to keep as far away as possible from United Kingdom ports. It would be impracticable to bring this system into force at a time of normal trade with Russia and satellite countries.

5. Any action of the kind discussed in the preceding paragraph would involve some element of open discrimination against the Soviet Union; it would invite retaliation in some form; and it would probably have serious political and economic consequences. Moreover, even if those consequences could be accepted, this type of action could not completely exclude the risk. For even, if it were possible by this type of action to keep all Russian, Polish and Roumanian ships away from the main target areas, the enemy could, if he were so minded, defeat all these precautions by chartering an innocent-looking ship of another flag and using it for a clandestine atomic attack or by placing his bomb in crated merchandise consigned to this country by a neutral vessel normally trading to a U.K. port.

Supervision of Diplomatic Freight

6. If the enemy wished to introduce an atomic bomb into this country in parts and assemble them here, as suggested in paragraph 2(ii) above, the parts would probably be consigned to the Soviet Embassy in London as diplomatic freight. A foreign Embassy has an absolute right to receive by diplomatic courier correspondence which is exempt from any examination by the territorial authorities. It has a further right to import certain things without paying Customs duty, but the territorial authorities are entitled to verify that diplomatic freight and diplomatic bags are not being abused as a method of importing things which are neither documents nor things which the Embassy has a right to import without paying Customs duty. It would therefore be permissible for us to open the Soviet diplomatic bag or to examine diplomatic freight for this purpose, provided that this were done in the presence of a member of the Soviet Embassy and that no attempt was made to open seals on any documents in envelopes. There would, however, be serious risks in doing so. We should invite immediate reprisals, which might involve widespread interference with our arrangements for supplying our own diplomatic missions behind the Iron

Curtain. In an exchange of discourtesies like this, we should normally have more to lose than to gain. Action of this kind could not fail to increase international tension. These disadvantages are certain. The gain, on the other hand, would be problematical; for we understand that, even if packages were opened and subjected to expert inspection, it could not be established with certainty that the contents were not parts of an atomic bomb.

7. Although it may be impracticable to prevent the importation of parts of an atomic bomb into this country, whether as diplomatic freight or otherwise, it is just possible that we might be able to detect the preparation for its assembly. This process would probably be directed and controlled through the Soviet Embassy in London, and it might be possible by increased vigilance to detect suspicious movements of vehicles to and from the Embassy. That is a point which we should like to examine further. It is of course by no means certain that we should be able by this means to secure, until it was too late, any positive indication that a bomb was being assembled here.

<u>Conclusion</u>

8. It is clear that it would be practicable for the Russians to introduce an atomic bomb into this country by clandestine methods. It is equally clear that there is no certain method of preventing them from doing so. The most that we could secure, by taking any of the measures discussed in this minute, would be to make their task more difficult. And the adoption of any of these measures would involve considerable risks and serious political and economic difficulties. This being so, it seems legitimate to ask whether the Russians would think it worth while to adopt these elaborate clandestine methods of launching an atomic attack when a military aircraft might do the job more effectively for them. An even larger question is whether the Russians would think it was worth their while to invite immediate retaliation by atomic attack against themselves so long as the advantage in numbers of atomic bombs remains overwhelmingly with the Americans.

9. The Chiefs of Staff have already arranged for an official working party (comprising representatives of the interested civil Departments) to consider means of guarding against this risk, and the possible

counter-measures discussed in this minute were all suggested in the report of this working party. The Chiefs of Staff have now asked me to arrange for further Departmental examination of these proposals and for any necessary submission to Ministers. For the reasons indicated in this minute I am very doubtful whether the increased security which might be obtained by adopting any of these measures could outweigh the very serious disadvantages, political and economic, which would be entailed. I have therefore thought it desirable to seek your guidance in the matter before asking Departments to undertake the work of assessing those disadvantages. You may like to discuss the problem with the Foreign Secretary and the Minister of Defence; but I suggest that, for the moment, it would be preferable that it should not be discussed in any wider group of Ministers.

(Signed) NORMAN BROOK

12th July, 1951

THE EFFECTS OF
HIGH-YIELD NUCLEAR EXPLOSIONS

Statement by

Lewis L. Strauss, Chairman

and

A Report by

The United States Atomic Energy Commission

February 1955

PROTECTION AGAINST FALLOUT

In an area of heavy fallout the greatest radiological hazard is that of exposure to *external* radiation, which can be greatly reduced by simple precautionary measures. Exposure can be reduced by taking shelter and by simple decontamination measures. Test data indicates that the radiation level, i. e., the rate of exposure, indoors on the first floor of an ordinary frame house in a fallout area would be about one-half the level out of doors. Even greater protection would be afforded by a brick or stone house. Taking shelter in the basement of an average residence would reduce the radiation level to about one-tenth that experienced out of doors. Shelter in an old-fashioned cyclone cellar, with a covering of earth three feet thick, would reduce the radiation level to about 1/5000, or down to a level completely safe, in even the most heavily contaminated area. Designs of shelters of simple yet effective construction have been prepared by the Civil Defense Administration and are available to the public.

Radioactive material deposited during the fallout may or may not be visible but would be revealed by radiation detection instruments such as Geiger counters. Any falling dust or ash that can be seen down-wind within a few hours after a nuclear explosion should be regarded as radioative until measured by a radiation detection instrument.

Care should be taken to avoid the use of solid foods or liquids that may contain fallout particles.

If fallout particles come into contact with the skin, hair, or clothing, prompt decontamination precautions such as have been outlined by the Federal Civil Defense Administration will greatly reduce the danger. These include such simple measures as *thorough bathing of exposed parts of the body and a change of clothing.*

INTERNAL RADIATION EFFECTS

Two other factors must be considered in evaluating possible hazards from radioactive fallout. The first is the effect of internal radiation from fallout particles swallowed in food or liquids. The second is the effect of radiation upon the germ cells which transmit inherited characteristics from one generation to another. It should be noted that in neither case is there reason to believe that weapons testing programs of the United States have resulted in any serious public hazard.

The radioactive forms of strontium and iodine are the constituents of fallout which are of principal concern as internal sources of radiation through ingestion. The concentrations of these substances from

STATEMENT BY LEWIS L. STRAUSS, CHAIRMAN UNITED STATES ATOMIC ENERGY COMMISSION

At a news conference on December 17, 1954, I stated that the staff of the Atomic Energy Commission was studying the subject of fallout and expressed the hope that information about it would be made public at a later date. "Fallout" is the word now applied to a phenomenon that follows the explosion of a nuclear weapon. Such an explosion, if the fireball touches the surface of the earth, draws up large amounts of materials into the bomb cloud. These materials subsequently fall back to earth as radioactive particles over a large area, mostly down-wind and relatively close to the point of explosion—although the lighter particles are carried great distances. The main radioactivity of fallout decreases very rapidly with time—for the most part, within the first hours after the explosion. An in-the-air explosion where the fireball does not touch the earth's surface does not produce any serious radiological fallout hazard.

Since nuclear weapons are in possession of the USSR, the Commission believes the American people wish to be informed regarding the dangers of nuclear explosions and the measures which individuals can take to protect themselves if an atomic attack should ever occur. Therefore, the Commission has condensed in the attached Report the information which can be made public at this time on the effects of the explosions of high-yield nuclear weapons.

The following excerpts and summarized sections contain the highlights of the Report itself.

FALLOUT PATTERN OF 1954 TEST IN THE PACIFIC

The very large thermonuclear device tested at Bikini Atoll on March 1, 1954, was detonated on a coral island and the ensuing fallout contaminated an elongated, cigar-shaped area extending approximately *220 statute miles down-wind and varying in width up to 40 miles.* In addition, there was a contaminated area up-wind and cross-wind extending possibly 20 miles from the point of detonation. Data was collected from 25 points on 5 atolls located from 10 to 330 miles down-wind (generally east) from Bikini Atoll. Due to an unexpected shift in the direction of the prevailing winds in the higher altitudes, the fallout missed the observation rafts that had been placed farther north

A REPORT BY THE UNITED STATES ATOMIC ENERGY COMMISSION ON THE EFFECTS OF HIGH-YIELD NUCLEAR EXPLOSIONS

1. Considerable information on the effects of the explosions of atomic weapons has been made public by the Government since the first nuclear detonations in 1945. The handbook, "The Effects of Atomic Weapons", published in 1950, is being revised and brought up to date to include the effects of thermonuclear weapons, as a result of the most recent tests at the Pacific Proving Grounds. References to the effects of thermonuclear explosions have been made in several official statements, beginning with Chairman Strauss' description of the phenomenon of "fallout" at a White House news conference on March 31, 1954. The following statement is designed to condense and correlate information, some of which already has been made public and other portions of which have been of a classified nature until now.

2. The effects of nuclear tests are evaluated for civil defense planning as well as for military and technological purposes. So long as nuclear weapons are in possession of any unfriendly power, the Commission believes the American public will wish to be as fully informed as possible as to the nature and extent of the dangers of nuclear attack and of the protective measures that can be taken by individuals and communities to avoid or minimize those dangers if we should be attacked.

3. Test conditions, which must necessarily form the principal basis of evaluating the effects of nuclear explosions, may differ markedly from those which might be expected if nuclear weapons were used against our population in wartime. It would be difficult to predict the size or kind of bomb an enemy might use against us in event of war, the exact means of its delivery, the height at which it would be exploded, or the number of bombs which might reach a given target. Nevertheless, the facts to follow are the fundamental ones at this time.

FOUR EFFECTS OF DETONATIONS

4. A nuclear detonation produces four major characteristics—blast, heat, immediate nuclear radiation, and residual radioactivity. Of these, the first three are essentially instantaneous, while the fourth has a more protracted effect. The phenomena of blast, heat, and nuclear radiation from the detonation of a thermonuclear bomb are

23. Thus, about 7,000 square miles of territory down-wind from the point of burst was so contaminated that survival *might* have depended upon prompt evacuation of the area or upon taking shelter and other protective measures.

24. At a distance of 220 miles or more down-wind, it is unlikely that any deaths would have occurred from radioactivity even if persons there had remained exposed up to 48 hours and had taken no safety measures.

25. The estimates cited above do not apply uniformly throughout the contaminated area inasmuch as the intensity of radioactivity within a region of heavy fallout will vary from point to point due to such factors as air currents, rain, snow, and other atmospheric conditions. Because of this and because most persons, if given sufficient warning, probably would evacuate the area or take shelter and other precautionary measures, the actual percentage of deaths could reasonably be presumed to be considerably *smaller* than these extreme estimates.

PROTECTION AGAINST FALLOUT

26. In an area of heavy fallout the greatest radiological hazard is that of exposure to *external* radiation. Simple precautionary measures can greatly reduce the hazard to life. Exposure can be reduced by taking shelter and by utilizing simple decontamination measures until such times as persons can leave the area. Test data indicate that the radiation level, i. e., the rate of exposure, indoors on the first floor of an ordinary frame house in a fallout area would be about one-half the level out of doors. Even greater protection would be afforded by a brick or stone house. Taking shelter in the basement of an average residence would reduce the radiation level to about one-tenth that experienced out of doors. Shelter in an old-fashioned cyclone cellar, with a covering of earth three feet thick, would reduce the radiation level to about 1/5000, or down to a level completely safe, in even the most heavily contaminated area. Designs of shelters of simple yet effective construction have been prepared by the Civil Defense Administration and are available to the public.

27. Radioactive material deposited during fallout may or may not be visible but would be revealed by radiation detection instruments such as Geiger counters. Any falling dust or ash that can be seen down-wind within a few hours after a nuclear explosion should be regarded as radioactive until measured by a radiation detection instrument and found to be harmless.

28. Care should be taken to avoid the use of solid foods or liquids that may contain fallout particles.

SUMMARY

42. The Atomic Energy Commission hopes that the information on nuclear weapons effects contained in the foregoing report will never be reflected in human experience as the result of war. However, until the possibility of an atomic attack is eliminated by a workable international plan for general disarmament, the study and evaluation of weapons effects and civil defense protection measures must be a necessary duty of our government.

43. Inevitably, a certain element of risk is involved in the testing of nuclear weapons, just as there is some risk in manufacturing conventional explosives or in transporting inflammable substances such as oil or gasoline on our streets and highways. The degree of risk must be balanced against the great importance of the test programs to the security of the nation and of the free world. However, the degree of hazard can be evaluated with considerable accuracy and test conditions can be controlled to hold it to a minimum. None of the extensive data collected from all tests shows that residual radioactivity is being concentrated in dangerous amounts anywhere in the world outside the testing areas.

44. In the event of war involving the use of atomic weapons, the fallout from large nuclear bombs exploded on or near the surface would create serious hazards to civilian populations in large areas outside the target zones. However, as mentioned in the foregoing Report, there are many simple and highly effective precautionary measures which must be taken by individuals to reduce casualties to a minimum outside the immediate area of complete or near-complete destruction by blast and heat. Many of these protective measures, such as shelter and decontamination procedures, have been detailed by the Federal Civil Defense Administration.

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ATOMS, NATURE, and MAN

Man-made Radioactivity in the Environment

by Neal O. Hines

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1966

Survival of an Animal Population

Engebi Island, on Eniwetok's northeast reef, is the home of a wholly self-contained colony of Pacific rats living in a network of burrows in the shallow coral sands. After 1948 Engebi was exposed repeatedly to atomic detonations, and in 1952 the whole island was swept clean of growth and overwashed by waves from the thermonuclear explosion of Operation Ivy. On each of these occasions, exposure of the rat colony to radiation was intense. In 1952, by later estimates, the animals aboveground received radiation doses of 2500 to 6000 roentgens per hour, and those in burrows doses of 112 to 1112 roentgens per hour. The island environment was so altered by atomic forces and by contaminated water that radiobiologists believed it impossible that any of the rats had survived. Because there was no natural route by which the island could be repopulated, scientists even considered introducing a new rat colony for study of a population growth in a mildly radioactive environment.

Engebi Island, Eniwetok Atoll, home of a colony of rats living in radioactive surroundings. Close-up shows one burrow in the soil.

Contrary to all expectations, however, the original colony had not been eliminated. Biologists visiting Engebi in 1953 and 1954 found the rats apparently flourishing. New generations of rats were being born and were subsisting on grasses and other plants in an environment still slightly radioactive. In 1955 analysis of the bones of rats revealed the presence of strontium-89 and strontium-90 in amounts that would not cause bodily harm. The rats' muscle tissues contained radioactive cesium-137. But no physical malformations were found in the rats. All animals appeared in sound physical condition, despite these body burdens of radioactivity. By 1964 the rat population had so increased that it apparently had reached equilibrium with available

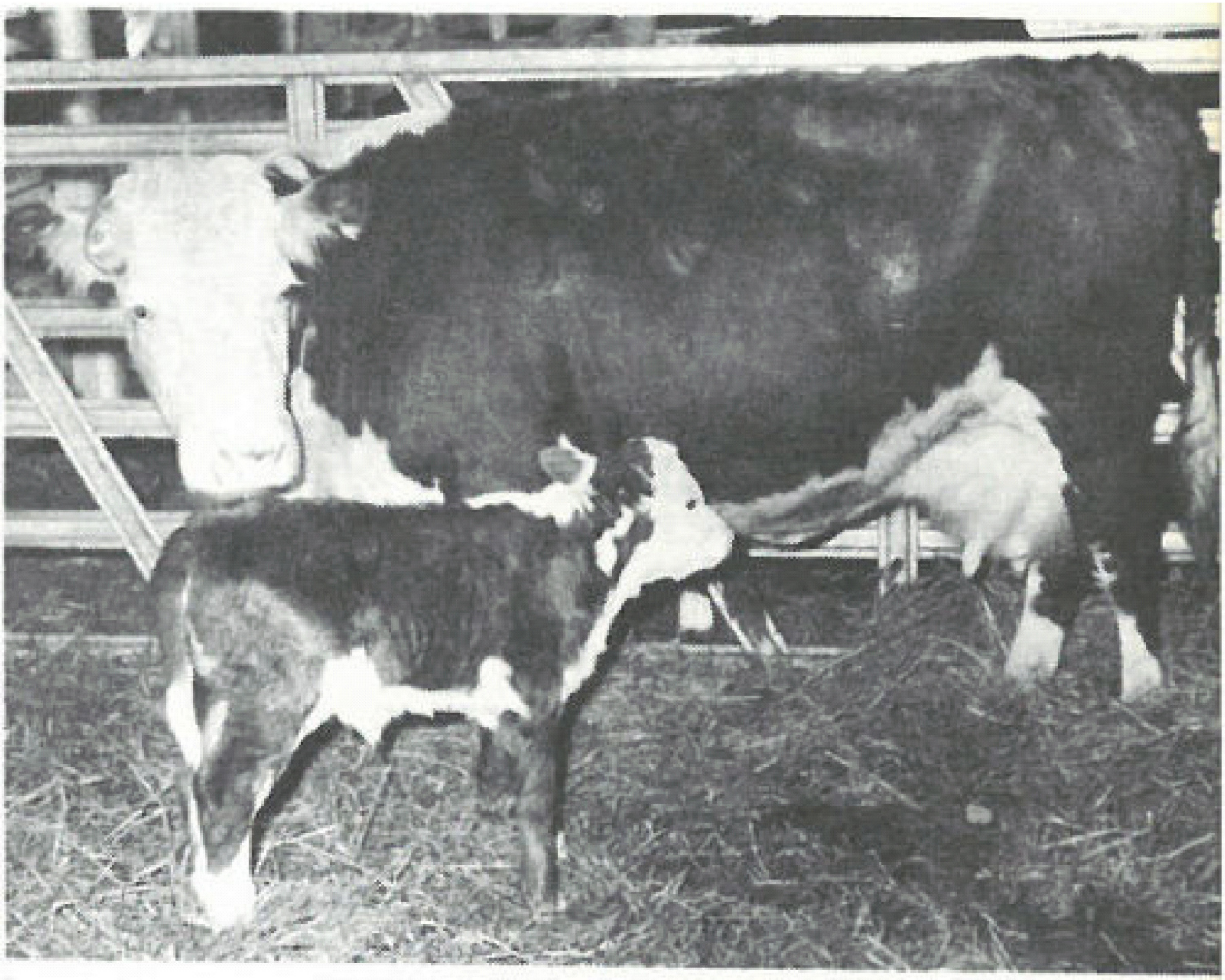
White-capped noddy tern nesting colony, Engebi Island, Eniwetok Atoll, photographed in 1965.

After 1951 each of the test programs had its radiobiological component. In the Pacific, radiobiological surveys were associated with Operation Ivy (1952), Operation Castle (1954), Operation Redwing (1956), and Operation Hardtack (1958). A small field station, the Eniwetok Marine Biology Laboratory, was established for use by scientists conducting biological studies. Bikini was incorporated into the Pacific Proving Ground in 1953, and new biological surveys were performed there in connection with the tests of 1954 and later.

A native rat, captured alive on Engebi Island

A thriving Messerschmidia *plant growing on Rongelap Atoll is studied for growth-rate and root-systems data after the island was accidentally subjected to radioactive fallout.*

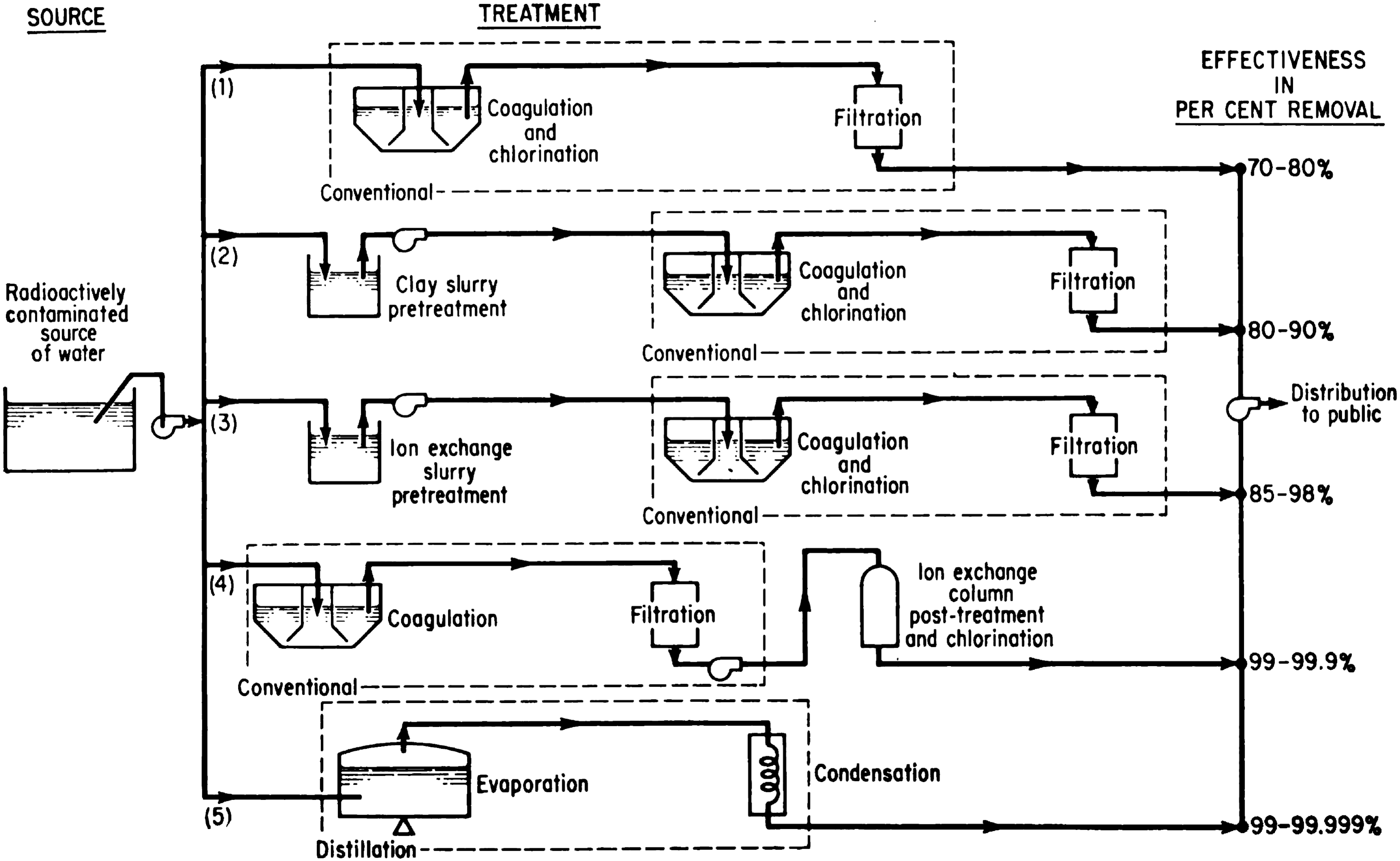
School of surgeonfish off Arji Island, Bikini Atoll, August 1964. Note coral growth on lagoon bottom.



One of the last cows of the herd exposed to fallout by the world's first atomic detonation in New Mexico in July 1945, photographed in 1964. The calf is her 15th to be born in 15 years. The cow, believed about 20 years old, has been under observation by scientists, who found she suffered little apparent effect, although the fallout caused some hair to turn gray (see light patches on back). Other cows in the herd died natural deaths.

THE AUTHOR

NEAL O. HINES is an established writer and experienced academic administrator with an unusual background in radiobiological surveys of the Pacific Ocean atomic test sites. He holds degrees from Indiana and Northwestern Universities. A former journalism teacher at the University of California and Assistant to the President of the University of Washington, Mr. Hines also worked for a number of years with the Laboratory of Radiation Biology of the University of Washington, where he served from 1961-1963 as administrative assistant and as Executive Secretary of the Advisory Council on Nuclear Energy and Radiation for the State of Washington. He was a member of the survey teams visiting Bikini and Eniwetok in 1949 and 1956 and Christmas Island in 1962. His "Bikini Report" (*Scientific Monthly*, February 1951) was one of the earliest descriptions of radiobiological studies in the Pacific. He is the author of *Proving Ground* (University of Washington Press, 1962), a detailed history of radiobiological studies in the Pacific from 1946-1961.



The decontaminating effectiveness of various water-treatment processes. (*Lacy & Stangler*, 1962.)

William J. Lacy & Marlow J. Stangler, "The Postattack Water-Contamination Problem", Health Physics, v8, issue 4, August 1962

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KEEPING THE PEACE

(DUTIES IN SUPPORT OF THE CIVIL POWER)

1957

This pamphlet supersedes Imperial Policing and Duties in Aid of the Civil Power, 1949 (WO Code No. 8439).

By Command of the Army Council,

E. W. Playfair

THE WAR OFFICE,
10*th April*, 1957.

RESTRICTED

The information given in this document is not to be communicated, either directly or indirectly, to the Press or to any person not authorized to receive it

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KEEPING THE PEACE

(DUTIES IN SUPPORT OF THE CIVIL POWER)

1957

PART I—GENERAL

CHAPTER I

INTRODUCTION

SECTION 1—GENERAL

1. Both at home and in the British dependencies overseas, British armed forces must always be ready to comply at once with any request from the civil authorities for assistance in maintaining peace or in restoring law and order. Also, during a state of emergency, they may be called upon to assist in maintaining public or other services essential to the life of a community.

2. The sole aim of military intervention to deal with general unrest is the restoration of law and order by military means when other methods have failed, or appear certain to fail. This aim must be clear in the minds of commanders at all levels and there must be a readiness to co-operate closely with the civil authorities and police. These are requirements of the first importance.

3. Once a request has been made for military assistance to restore law and order, the military commander, irrespective of his rank, is entirely responsible for the form which the action shall take. However, he should be guided by the advice of the civil authorities and police.

4. Disorders, especially in territories outside the United Kingdom, may take many forms. They can run the whole gamut from isolated local disturbances such as dock strikes, to large scale violence employing all the known techniques of subversion and even armed rebellion, aimed at overthrowing the established government.

5. Full scale revolts, although they do not occur frequently, generally break out on a scale likely to stretch any government's resources to the utmost and take a long time to bring under control. They may be largely indigenous in origin or they may be inspired from outside. But whatever their character, whether political, racial or religious, those who direct them lose no opportunity to stir up trouble by playing on the prejudices, fears and hopes of often unsophisticated people. They can cause prolonged outbreaks of violence and consequently create a problem of maintaining law and order to overcome which requires full scale counter-measures and the closest co-operation between the security forces and the civil authorities.

6. Recent experience overseas has revealed a fairly standard pattern for internal unrest of this kind as follows :—

Phase I. Terrorism to obtain the support of local personnel and access to material resources ; to frighten the local population out of giving information to the authorities ; to embarrass and cause disaffection among the forces of law and order (particularly those who are locally recruited) and to tie down security forces to static tasks.

Phase II. The creation of base areas under insurgent control (whether by propaganda, compulsion or terrorist methods), for purposes of food storage, concealment and recruitment.

Phase III. The complete control of large areas where an insurgent government can be proclaimed and where training and organization can proceed unhindered.

Phase IV. The complete overthrow of the established government.

7. To defeat this plan of unrest, the vital need is to prevent it ever getting beyond Phase I. This can only be done by having adequate police and military forces available to intervene promptly in support of the local government, so that it can react firmly to the threat to its existence. The police must be used on police tasks, such as obtaining information and providing static guards, while the military must be used for mobile operations which may vary from operations in thickly populated urban areas to hunts, covering large areas in jungle or mountain country, for terrorists.

8. In making his appreciation and in deciding his plan of military intervention in support of the civil power, a commander should be guided by the following principles :—

(*a*) *Necessity.*—There must be a necessity and justification for each separate act.

(*b*) *Prevention.*—This must be the reason for using military force; it must never be applied with punitive intent.

(*c*) *Minimum force.*—No more force must be used than is absolutely necessary to achieve the immediate aim.

(*d*) *Impartiality.*—Members of the armed forces must act impartially and calmly, and they must comply strictly with the law.

9. Finally, a commander must remember that when supporting the civil power his troops generally will be greatly outnumbered. The ability to counterbalance this disadvantage depends on good leadership, training, discipline and, in the last resort, skill in using weapons in such conditions as to produce exactly the effect which is needed.

10. The rules for the employment of troops in support of the civil power are given in the Manual of Military Law, Part II, Section 5. The legal aspects which are of vital importance are discussed in chapter 2 of this book.

25. Finally, when force is being used :—

(*a*) It must be applied in good faith, impartially and with preventive and not punitive intent.

(*b*) It must not be continued longer than is necessary to justify the immediate aim, i.e., the stopping of unlawful actions of offenders.

(*c*) A commander must not exceed his duty in one instance or at one place because it is his personal opinion that the effect will be beneficial in another instance or at another place.

SECTION 4—CIVIL DISTURBANCES

26. The types of disturbances in which troops may be called upon to intervene matter little and the principles set forth in the preceding paragraphs apply to each and every type. An explanation of the law relating to unlawful assemblies, riots and insurrections or rebellions will be useful to military commanders and is therefore given below.

Unlawful assemblies

27. An unlawful assembly is an assembly of three or more persons with intent either to commit a crime by open force or to carry out any common purpose (lawful or unlawful) in such a manner as to give firm and courageous persons in the neighbourhood of such assembly reasonable grounds to apprehend a breach of the peace in consequence of it. The commission of an act of violence by any one or more of those assembled is not necessary to make the assembly unlawful, if its character and circumstances are such as to be calculated to alarm not only foolish timid people but people of reasonable firmness and courage.

28. An unlawful assembly may be dispersed, although it has committed no act of violence. The civil authorities have power to command the persons forming it to go away, to arrest them if they do not go and to stop others whom they see joining them. If the civil authorities are resisted they may use such force as will compel obedience but it would be extremely inadvisable for them to use any such force as would maim or injure a person resisting, unless that person himself makes an attack inflicting, or calculated to inflict, grievous personal injury on his captor.

Riots

29. A riot is a tumultuous disturbance of the peace by three or more persons assembled together without lawful authority with an intent mutually to assist one another, by force if necessary, against any who should oppose them in the execution of some enterprise of a private nature and who afterwards actually begin to execute that enterprise in a violent and turbulent manner to the terror of other people. It is

and one cannot immediately be procured. A person lawfully making an arrest with or without a warrant may, without retreating, use such force as is necessary to overcome opposition and effect the arrest.

SECTION 6—STATE OF EMERGENCY

40. In the United Kingdom, colonies and protectorates, when an emergency arises which cannot be dealt with by the civil authorities under the ordinary law, even with the aid of military forces, emergency legislation is passed or brought into force giving the authorities special powers to deal with the emergency. Such special powers often enable the military authorities to exercise a greater degree of control than is normally the case. The civil administration, however, retains its independence but co-operates with the military commander in giving effect to the terms of this special legislation. Although such emergency legislation may tend to create dual responsibility between the civil and military authorities, this duality of responsibility is more theoretical than real and, as far as military authorities are concerned, any disadvantage is more than counterbalanced by the additional powers which the emergency legislation gives. Such emergency legislation cannot hope to provide in advance for all possible developments of the situation and if any additional powers are needed they must be asked for without delay. It is the responsibility of the military commander to make his requirements known to the local government in this respect.

SECTION 7—MARTIAL LAW

41. Military participation under emergency legislation does not constitute "martial law" and it is extremely unlikely that a proclamation of martial law will ever be made.

SECTION 8—REFERENCES IN MANUAL OF MILITARY LAW

42. The account of the law given in this chapter is sufficient for all practical purposes. However, when time permits, all officers will read the following :—

(*a*) Manual of Military Law, Part II, Sec. V (Employment of Troops in aid of the Civil Power).

(*b*) Manual of Military Law, 1956, Part I, Chapter 5, paras. 14 (Arrest), 17 (Self-Defence) and 18 (Protection of Persons and Property).

(*c*) Manual of Military Law, 1956, Part I, Chapter 1, paras. 10 to 13 (Martial Law and Emergency Legislation).

SECTION 9—CONCLUSION

43. Finally, it is again emphasized that a military commander should remember that **if the measures which he takes are, or he believes on reasonable grounds that they are, necessary to achieve his immediate object and he acts in good faith he need not fear the result of any inquiry into his conduct.**

CHAPTER 3

METHODS OF SUPPRESSING UNLAWFUL ASSEMBLIES AND RIOTS

SECTION 10—INTRODUCTION

44. This chapter explains in detail the action which should be taken by the armed forces when suppressing an unlawful assembly or a riot in the United Kingdom or in any other country where the English law (as explained in chapter 2) applies. In countries where the English law has been modified the instructions given in this chapter will have to be adapted to meet the requirements of the local law. It is essential therefore that all military commanders should acquaint themselves with local law.

45. If widespread disorders are expected, military intervention to deal with unlawful assemblies and riots needs to be pre-planned and rehearsed by the civil police and military authorities together. Outline plans should cover the following :—

(*a*) An assessment of the different types of disturbance likely to develop, their probable locations and strength and action needed to suppress them.

(*b*) An assessment of what troops will be required for each locality and the earmarking of a specific unit for each task.

(*c*) Arrangements for joint and discreet reconnaissances as necessary.

(*d*) The channels through which requests for military assistance will be made.

(*e*) Arrangements for establishing joint military/police operational headquarters.

(*f*) The preparation of any special stores likely to be needed, e.g., warning banners in appropriate languages.

(*g*) Training and rehearsal of all concerned, including the testing of communications and the procedure for handing over/taking over a riotous situation.

46. When armed forces are called upon to deal with an unlawful assembly or a riot it is highly desirable for each body of troops to be accompanied by a magistrate or his representative.

47. Military commanders must be prepared to intervene on their own authority if necessary (*see* chapter 2, para. 18).

48. Troops should be ready to intervene immediately on arrival at the scene of a disturbance, for if there is a delay it tends to allow a build up in front of them.

SECTION 11—DISPERSAL OF A CROWD

49. Once it is deemed necessary for armed forces to intervene, the military commander is entirely responsible for deciding what action is required by him to restore the situation. At the same time he should be guided by any advice given to him by the police or civil authorities.

50. If possible a commander will first try to disperse a crowd by non-violent means, e.g. :—

(*a*) Verbal and visual persuasion, using loudspeakers, banners and bugles, etc.

(*b*) The reading by a magistrate or other authorized civil authority of the proclamation under the Riot Act (*see* chapter 2, para. 30), or its equivalent abroad.

(*c*) Producing cameras to photograph ringleaders, agitators and others to enable them to be identified later as disturbers of the peace.

(*d*) The steady advance of a line of soldiers with fixed bayonets. However, this form of threat must only be used if the commander is quite certain in his own mind that there will be no danger of the troops coming into close contact with the crowd, as this will inevitably lead to hand-to-hand fighting, dispersion, loss of control and, perhaps, the use of more than minimum force by individual soldiers.

51. If all these methods are ineffective or impracticable, then more drastic action will have to be taken.

SECTION 12—OPENING FIRE

52. The responsibility for deciding to fire is solely that of the military commander on the spot. If possible he should consult with any representatives of the civil authorities present before ordering fire but he cannot ask them to take or share the responsibility for his actions.

53. When the military commander decides that fire must be resorted to in order to restore a situation, as far as possible the subsequent action will be as follows :—

(*a*) The crowd will be warned by all available means that effective fire will be opened unless it disperses at once.

(*b*) The order to fire will be given by the military commander himself to the fire unit commander(s) concerned. He will indicate the target and the number of rounds to be fired and ensure that only the minimum amount of force necessary is used.

CHAPTER 7

SECURITY FORCES

SECTION 33—THE PATTERN OF UNREST

131. Broadly speaking, there are three types of disturbances that may develop in a dependent territory :—

(*a*) *Civil disturbances* which are caused mainly by political, labour, religious and racial disputes leading to sporadic and isolated outbreaks of violence.

(*b*) *Civil insurrection* which may arise from any of the causes mentioned in (*a*) above, but which has a much greater degree of public support and is usually far more widespread. It may also arise out of attempts to hasten independence and self-government. The degree to which the objectives of dissident elements will command the sympathy of the established government will differ.

(*c*) *Cold war or general rebellion* which may be either communist-inspired or arise out of a local rebellion against British sovereignty or even westernization. Whichever form it takes, it makes use of local dissidents to fight the government with the aim of seizing power for its leaders. This type of rebellion does not really have the support of the majority of the population, but the leaders are able to terrorize a fair proportion either into taking an active part or at least acquiescing.

132. These conditions may occur singly or concurrently, and ultimately they may make necessary the intervention of security forces and the declaration of a state of emergency.

SECTION 34—HIGH COMMAND

133. The form of high command organization needed to deal with a state of emergency will depend on the type of constitution that exists in the country, the extent of the disturbance and the size of the available security forces.

134. The overall responsibility for restoring law and order rests fairly and squarely with the civil government, as long as one exists, but the necessary action needs to be initiated and conducted by the civil, police and military commanders together at all the appropriate levels. This can be done at the top level either by the appointment of a **director of operations** or by a form of **war council.**

171. Although the searching of individuals and property is primarily a police duty, on occasions it will have to be undertaken by soldiers who require training in the correct methods to be employed.

172. The importance of a high standard of turn-out and smartness needs to be emphasized constantly for civilians are very quick to notice such things and formulate their own opinion of the efficiency of military forces accordingly.

173. Physical fitness and the observance of rules of hygiene are normal requirements at all times, but they require emphasis when training troops for operations in a country subject to adverse climatic conditions.

Intercommunication

174. For internal security operations adequate communications are essential for the rapid passing of information. If they do not exist the necessary action by troops will be delayed and, consequently, it will be less effective. All operational lines of communication need to be duplicated as far as is practicable. RADIO

175. Communications should be based on the wireless, since telephones will often be unreliable due to sabotage, tapping and adverse climatic conditions. If practicable, wireless should be supplemented by other methods such as visual telegraphy, an air despatch service and even carrier pigeons.

176. Commanders must be able to talk direct and without delay to their opposite numbers in the police and administration. Where police nets exist military formations and units should become out-stations.

177. The use of despatch riders should be kept to the minimum, since they are easily ambushed. When used they must operate in pairs and, if possible, in vehicles as opposed to motor cycles.

SECTION 41—ANTI-TERRORIST OPERATIONS

Enemy characteristics

178. The majority of terrorists are members of the local population, who carry out acts of violence against both civilians and the armed forces on behalf of revolutionary organizations. Their fighting characteristics are as follows :—

(*a*) Terrorists may be both male and female, well armed with small arms and explosives, but lacking larger and more modern weapons.

(*b*) Terrorists are highly skilled at sabotage using time and home-made bombs, ambushes and hit and run attacks against military, police and civilians. They are also masters of fieldcraft with an intimate knowledge of the ground over which they operate. Initially they may be able to " demand " friendship everywhere.

(*c*) The chain of command of terrorists is difficult to penetrate or disrupt. It may be based on a "cell" system which stretches throughout the country, or it may have its roots, quite illegally, in a neighbouring border country. Some of the high commanders and others may be foreigners.

(*d*) Terrorists seldom have a recognizable administrative or intercommunication system.

179. When fighting, terrorists invariably use guerilla tactics. Their main efforts are made against easy targets, preferably against individuals, small parties and anyone who is defenceless or isolated. Their attacks are launched both in towns and in the open country. They seldom attack security forces, except on ground of their own choosing and when there is a chance of achieving surprise. As hunted men and women, terrorists soon become ruthless and cruel and they use extortion and force against defenceless persons to obtain anything they require.

Military tactics

180. In the early days of an emergency it may be necessary for security forces to become dispersed in a semi-static role to cover the expansion of the police, the creation of additional auxiliary forces, the time required for the passing of emergency legislation and the arrival of military reinforcements. But, as a permanent policy, dispersion relinquishes the initiative to the enemy, it is bad for morale and it will lead to ever-increasing terrorist activity. These tactics will never end an emergency.

181. The only effective course to adopt against terrorists is to concentrate against them with offensive action. Troops should be moved to areas where it is known that terrorists are operating, even if it is jungle or forest, and then the enemy must be located, engaged and finally destroyed.

182. Finally, there are three main ways in which terrorists can be brought to battle :—

(*a*) By luring into a trap or ambush.

(*b*) By sweeping an area.

(*c*) By patrolling.

Which of these courses, or combination of courses, is employed will depend on the nature of the country, forces available and information about the terrorists.

Some notes on the carrying out of these operations are given in Part III of this book.

CHAPTER 9

INTELLIGENCE

Section 44—INTRODUCTION

194. Intelligence is required on the broadest possible basis for the purposes of government and for the formulation of a government's political and security policies. It is required for the defence of a country against internal or external dangers arising from attempts at sabotage, espionage and from the activities of organizations and individuals who may be subversive to security. These are the permanent and standing requirements of any territory.

Tactical or operational intelligence is the intelligence required by security forces (civil and military) for purposes of taking action when disturbances have arisen.

195. Intelligence is the most important single factor in the prosecution of internal security operations. The terrorists' aim is to destroy the people's confidence in the ability of the government to protect them and, if successful, this results in members of the public refusing to come forward with information for fear of reprisals. In turn, this causes the drying up of intelligence sources of information. Without information, it is difficult to launch successful operations and without successful operations the confidence of the public cannot be restored. Therefore, from the onset, it is essential that early information is obtained about terrorist methods and habits without which security forces cannot train and operate successfully.

Section 45—ORGANIZATION

196. In a dependent territory the responsibility for the collection, collation and assessment of intelligence rests on the local government. It is the particular duty of the police and the Special Branch to collect information bearing on internal security, but the system is based on the direction of information from all sources (e.g., administrative officers, education and labour officers) into a single channel, with collation at all levels, leading to a central body whose duty is to produce a composite intelligence picture for the territory as a whole. This body usually takes the form of a local intelligence committee responsible to the governor. In most territories the governor also has the advice of a security liaison officer appointed by the UK Security Service who provides the link between the intelligence organization of the territory and the wider Commonwealth security network.

197. The chairman of the local intelligence committee is normally a senior administrative officer and sometimes he is designated the **director of intelligence.** Representatives of all the services and the

CHAPTER 10

THE WORD BATTLE

SECTION 48—PSYCHOLOGICAL WARFARE

218. It is the declared aim of HM Government that those people living under British rule will be guided along the road to self-government, and that the transfer of responsibility and power should be gradual in order to avoid detrimental consequences. When this aim is being imperilled by subversive propaganda and agitation, the counter balance must be provided by an efficient information service pursuing a sound, constructive and positive programme through the medium of newspapers, broadcasts, loudspeaker vans, etc.

219. If a situation deteriorates because of terrorist activities and a state of emergency has to be declared, there is need for a different type of information service, namely one which will carry out an offensive propaganda programme against the terrorist movement and act as a destructive force. Under such circumstances, it is necessary to apply the tactics of psychological warfare.

220. Psychological warfare is the planned use of psychological measures including information, propaganda, etc., designed to influence the opinions, emotions, attitude and behaviour of the enemy, neutral or friendly groups in support of current policy in time of war or emergency.

Tasks

221. The aim of psychological warfare under these conditions is as follows :—

(*a*) To undermine the confidence of terrorists in ultimate victory.

(*b*) To create confusion in the minds of terrorists about the righteousness of their policy, to weaken their will to fight and to cause distrust and dissension between leaders and men.

(*c*) To publicize the advantages and methods of surrender.

(*d*) To drive a wedge between dissident elements and the people, and to develop resistance to the political ideologies of their movements.

(*e*) To increase the confidence of the people in the government.

(*f*) To encourage active participation in the fight against terrorism on the side of the government.

(*g*) To make the righteousness of our aims clear to the people of the world.

222. Psychological warfare can be divided into three forms as under :—

(*a*) *Strategic.*—Strategic policy and action which need to be decided at the very highest level are part of the overall strategic plan. A continuous and relentless campaign must be aimed at the whole terrorist movement and the whole of the civil population.

(*b*) *Tactical.*—Tactical psychological warfare concerns the formation and regimental commander in the field more directly. Normally, it is aimed at a specific group of people or even an individual terrorist. It may be pre-planned in support of a single operation or it may have to be applied against an opportunity target which has suddenly presented itself. In the latter case, it requires prompt application.

(*c*) *Consolidation.*—Consolidation psychological warfare is directed entirely towards the civil population, to facilitate the organization of stable government, to gain the co-operation of the people and to counter enemy propaganda activities, thus securing lines of communications and assisting military operations.

Methods of application

223. Psychological warfare propaganda is applied by the following methods :—

(*a*) *The written word*—by means of leaflets, posters, pamphlets, books, special publications and the legitimate press.

(*b*) *The spoken word*—by means of radio, ground broadcasts, voice aircraft, surrendered personnel shock teams, films, discussion groups, public address systems and rumours.

224. The choice of media depends on their availability to the target audience and the standard of literacy and intelligence of the audience.

Effect

225. Psychological warfare deals with intangibles and therefore its effect is not always obvious. Immediate results are rare ; rather it is a relentless and remorseless campaign aimed at wearing down opponents. However, indirect results may be indicated by the external and internal propaganda of the subversive movement, the application of sanctions to prevent propaganda reaching their members and by promotions, demotions and executions.

226. The expert examination of captured documents and the interrogation of deserters are essential to psychological warfare operations to enable an analysis of results to be made.

Organization

227. Psychological warfare is an offensive weapon and its policy should be determined by the governor or war council responsible for the overall control of operations, but subject to direction from the United Kingdom on matters which may have external implications. Though many of the staff will be civilians, the responsibility for execution should rest with the director of operations or equivalent, working through a director of psychological warfare. The latter needs to have direct access to the governor or war council.

Finance

228. Psychological warfare cannot be run on the peacetime budget of the civil information service. Whether it is disseminated by leaflets, broadcasting or rumours it should be considered as ammunition and the cost calculated accordingly.

Conclusions

229. Psychological warfare is not an independent arm but an organic supporting weapon. The target is dictated by the current situation and the ammunition fashioned out of factual information. It cannot do miracles and it is not a substitute for action, or something to turn to when all else has failed.

230. Psychological warfare must operate inside the current operational plan and the overall strategy of the government, in support of its aims and objectives.

231. Psychological warfare is not deception. Moreover it must not be discredited. Its objectives can only be achieved by building up a reputation for credibility.

232. No subversive or terrorist movement can exist without support from the people. The support may be popular and voluntary or it may be involuntary through fear. Psychological warfare seeks to deny the movement that support which it requires, as well as to undermine terrorist morale.

SECTION 49—PRESS

233. A good public relations officer should be able to deal with most press matters on behalf of his commander. But, since the press dislike getting all their information second hand, it will be a great help if a commander can make himself available from time to time to talk to correspondents and, within reasonable limits, to be fairly accessible to them.

234. If press correspondents are forbidden to interview junior commanders and soldiers to obtain first hand stories, they may be justified in claiming that any errors in reporting were caused through

facilities and food distribution. If this happens, it will only result in driving neutrals into the enemy camp. It must be made clear to everyone, that any inconvenience and hardship caused to local inhabitants are not being inflicted with a punitive intent, but that they are a necessity to root out bad elements.

247. Military control over an area must not be continued a moment longer than necessary. As soon as there are indications of good behaviour and co-operation, the local inhabitants should be rewarded by the lifting of some of the restrictive measures. Later, a further reward can be the declaration of a " white area " with only limited control, and so on, until all restrictions can be withdrawn. This policy encourages good behaviour and acts as an incentive to other areas to drive out dissident elements and terrorists.

(Food control: Mau-Mau in Kenya; also Malaya)

SECTION 52—FOOD CONTROL

248. An effective method of waging war against guerilla terrorists is to introduce measures that aim to make it impossible for them to obtain food, medical supplies and other such items from local inhabitants. This can be done by reducing supplies to a bare minimum so that no one has any reserves available to give or sell to terrorists.

249. In order to deny food to terrorists, a system of control needs to be introduced, when legally permissible, by the following methods :—

(*a*) Crop growing restrictions.

(*b*) Supervision over and guarding of standing crops and stock.

(*c*) Control over harvests and food storage.

(*d*) Imposition of food rationing and the closing of trading centres.

(*e*) The prohibition of cultivation and cattle grazing adjacent to jungle or forests where terrorists are known to be located.

250. A combination of these restrictions may force terrorists to expose themselves more frequently in order to search for food, thus giving the security forces more chances of being able to bring them to battle. Also, they may force terrorists to divert manpower to undertake their own food cultivation.

251. The necessary action to control food supplies, etc., will be undertaken by the civil authorities in consultation with the military. Whenever possible, it should be civilian controlled with a specially appointed government official in charge. It requires careful planning, timing and co-ordination for, if imposed wrongly, it will cause hardship, create animosity towards the government and possibly international

CHAPTER 12

SEARCHING A BUILT-UP AREA OR VILLAGE

SECTION 53—ORGANIZATION

253. The large scale search of a built-up area or village is normally a combined police and military operation. If possible, it should be pre-planned in detail and rehearsed. In the event of the army having to undertake any form of search at short notice without police assistance, it should be conducted in the same way and the same principles should be observed, as far as they are applicable and practicable.

254. When undertaking a search everything possible must be done to maintain secrecy in order to achieve surprise. Reconnaissance of the area should be avoided and the information needed about the ground obtained from air photographs. For success, the plan needs to be simple and capable of rapid implementation. Methods and techniques also need to be constantly varied.

255. If sufficient troops and police are available the following parties should be organized for a search :—

(*a*) *Cordon troops.* Troops required to surround the area to be searched to prevent anyone inside from getting out.

(*b*) *Outer cordon troops.* Troops required to be located some distance from the main cordon at strategic points, to prevent an attack or interference from outside the isolated area.

(*c*) *Search parties.* Parties of police and troops to undertake the search of houses and inhabitants in the isolated area.

(*d*) *Cage troops.* Troops required to erect and guard cages for holding persons awaiting interrogation.

(*e*) *Screening teams.* Parties of civil police to identify suspects and wanted persons.

(*f*) *Escort troops.* Parties of troops with transport to escort wanted persons to a place of detention after interrogation.

(*g*) *Road blocks.* Parties of troops/police on roads to stop traffic trying to enter the isolated area.

(*h*) *Reserve.* Troops required at all levels to deal with the unexpected. It may be necessary to use some of the reserves :—

(i) to enforce a curfew and operate loudspeakers ;

(ii) to maintain an OP on a building in order to observe rooftops ;

(iii) to watch the reactions of persons being searched (similar to the psychological approach used by customs officers).

CHAPTER 14

SECURITY DUTIES

SECTION 60—ROAD BLOCKS

297. During an emergency, it will be necessary to maintain a continuous check on road movement with the aim of catching wanted persons and preventing the smuggling of arms, etc. This requires the provision of road blocks, some of which may have to be manned by the military.

298. Since road blocks cause inconvenience and even fear, it is important that the local population is made to understand that they are entirely a preventive and not punitive measure, directed solely against bad elements and law breakers.

Types

299. Broadly speaking, there are two types of road blocks :—

(*a*) *Deliberate*

(i) Positioned in a town or in the open country often on a main road.
(ii) To act as a useful deterrent to unlawful movement.
(iii) Unlikely to achieve spectacular results.

(*b*) *Hasty*

(i) Similarly positioned in a town or in the open country, but the actual location often related to some item of intelligence.
(ii) Require quick planning and implementation.
(iii) Initially may achieve a quick success, but once position is known, tends to become a deliberate road block.

300. Concealment of a road block is desirable, but often impossible, especially in a built up area. However, it should be located where it is at least difficult for a guilty person to turn back or reverse a vehicle without being noticed. Round a sharp bend or in a dip are good positions.

301. A road block must have adequate troops to make it secure, because it is a good target for a terrorist ambush. (Truck bombs)

302. A road block is best established by placing two parallel lines of knife rests (each with a gap) across the road, approximately 50 yards apart. The enclosure formed can then be used as the search area.

303. If possible, there should be a place in the search area where large vehicles can be examined without delaying the flow of other traffic which can be dealt with quickly. Since a road block must

Equipment

338. Certain additional equipment and weapons are required to enable the soldier to carry out the police role :—

(*a*) *Tear smoke.*—Tear smoke may be available, but it must be used with care as it is a double-edged weapon, in that much fatigue is caused to our own forces due to the necessity of having to wear respirators. The tendency to use tear smoke as the immediate solution to every situation must be resisted. The 91 grenade and riot gun have given the army the means of using tear smoke as a supporting weapon.

(*b*) *Batons.*—Baton sections will need to be equipped with batons, wooden or wire shields and visors if available. Shields should be secured to the forearm. Batons should be wielded with a lateral crossing movement aimed at the arms of a rioter, not his head. Baton parties should not wear web equipment or any article which gives a rioter an easy hand-hold.

(*c*) *Dye sprayers.*—Improvised dye sprayers may be available. If unwieldy, they are best carried on the seat of a ¼-ton truck, and operated by the passenger alongside the driver. The requirement is for a dye sprayer with a maximum range of 50 yards.

Training

339. It is essential that the police and army train together in anti-riot drill until they are thoroughly conversant with it. The drill needs to be simple and one that can be readily adapted to meet changing circumstances. It is essential that it is flexible. Probably the best method of ensuring that the riot striking force is properly organized and ready to do its task is for the military and police elements to train together regularly to practise forming up quickly, embussing, debussing and collective action under varying conditions.

Conclusion

340. It will be found that the soldier takes readily to this new role, mixes extremely well with the police and proves himself to be resolute and fully capable of dealing with unlawful assemblies and rioting by using police methods. But soldiers must not be left long in a police role for it puts an extra strain on administration and seriously reduces training for war.

CHAPTER 16

AMBUSHES, SWEEPS AND PATROLS

Section 64—THE TERRORIST AMBUSH

Enemy tactics

342. During a state of emergency, troops and vehicles of the security forces are likely to be subjected to terrorist ambushes, both in towns and outside, when carrying out their day to day duties. Therefore measures are needed to turn these ambushes into an opportunity to kill the enemy, as well as to reduce their effect to the minimum.

343. The aim of terrorists when conducting an ambush is to inflict casualties and if possible to capture arms and ammunition. An ambush is likely to have the following characteristics :—

(*a*) It is laid in a place where a target can be expected to appear within a fairly short time. The position chosen may be where vehicles tend to have to slow down, halt or become closed up, or where troops on foot have difficulty in moving over the ground.

(*b*) Outside a town or village, an ambush is likely to be conducted in close country from one or both sides of a road or track, up to a distance of 400 yards. In a town or village, it is likely to be made from or near buildings, particularly those that flank a narrow street. In both cases, the site chosen is certain to have good lines of withdrawal for the enemy.

(*c*) When conducting an ambush outside a town or village, terrorists often divide themselves into a firing group to kill, a charging group to finish off survivors and a capturing group to seize arms and equipment. In a built up area, an ambush is more likely to be made by one or two persons only, who strike and then disappear immediately.

(*d*) Fire is likely to come from rifles, automatic weapons and grenades. Mines and fallen trees may be used to block a route. In towns and villages, grenades are often thrown from a window or from behind a wall.

(*e*) A minor incident (not necessarily violent) may be created to try and draw troops into a killing ground where an ambush has been laid.

(*f*) Terrorists tend to conduct ambushes outside towns more often in daylight than in darkness, and particularly during the last few hours of daylight. In towns and villages, they may occur at any time.

authority and if they suffer any injury it may have repercussions of great magnitude. Furthermore, success by terrorists against a VIP will have tremendous propaganda value for their cause and enable them to claim a decisive victory over the security forces whom they are fighting.

354. Basically the measures to be taken to guard a VIP are those already described above, with the addition of the following points :—

(*a*) The strength of the escort required will depend on circumstances, but a convenient size is one platoon.

(*b*) There should be an armoured vehicle available in which the VIP can travel during any part of the journey when an attack is to be expected. At other times, the plan should make it possible for the VIP to travel in a more comfortable vehicle.

(*c*) Throughout the move, the vehicle carrying the VIP must be closely supported by a second vehicle carrying at least one automatic weapon and " bodyguard " troops. If possible this vehicle should be armoured.

(*d*) The vehicle carrying the VIP should not bear any special distinguishing marks.

(*e*) In the event of an attack, it is the duty of the " bodyguard " troops to protect the VIP, and to get his vehicle out of the danger area as quickly as possible.

(*f*) It may be desirable to provide air cover for the party, to make dummy and live runs along the route against possible ambush positions.

(*g*) The escort must have adequate wireless communications.

(*h*) Secrecy about the details of the move must be maintained as long as possible.

355. Before starting the move, the nominated escort commander should report to and brief the VIP as to what action he wishes him to take in the event of attack. Thereafter, the VIP will expect complete command to be exercised by the escort commander, even though he himself may be a senior service officer.

SECTION 65—THE ANTI-TERRORIST AMBUSH

356. The aim of an ambush laid by our own troops is to kill terrorists on ground of our own choosing. It may be laid as a result of information, suspicion or part of the overall plan.

357. To achieve success, spontaneous co-ordinated action on a surprised enemy held within a prepared killing area is needed. This requires :—

(*a*) Careful planning and briefing.

(*b*) First class security at all stages.

(*c*) Concealment of all signs of the approach and occupation of the position.

(*d*) Intelligent layout and siting.

(*e*) Rigid control throughout the operation.

(*f*) Rehearsals of action needed on the approach of an enemy.

Planning

358. Good ambush areas are a bend in a track or road, a clearing, a water hole, a defile or a water crossing. Information about suitable locations can be obtained from police, maps, air photographs and previous patrol reports. When choosing, obvious places are not always the best and cunning is needed.

359. All members of the ambush party must be fully briefed. A sound plan is to hold a preliminary briefing before departure, followed by a final briefing in the ambush area after the commander has been able to see the actual ground.

Layout

360. An ambush can be located on one or both sides of the selected killing ground, though in the latter case there is always a danger of two parties firing at each other. Normally, it is best to occupy only one side of the chosen killing area and seal the other with booby traps, wire and other obstacles.

361. When siting an ambush position the following principles need to be observed :—

(*a*) The killing ground can be covered by fire with the available weapons and once the enemy is inside he cannot easily escape.

(*b*) There are good fire positions with cover for our own troops.

(*c*) There are positions where look-outs can be posted and for any necessary administrative area.

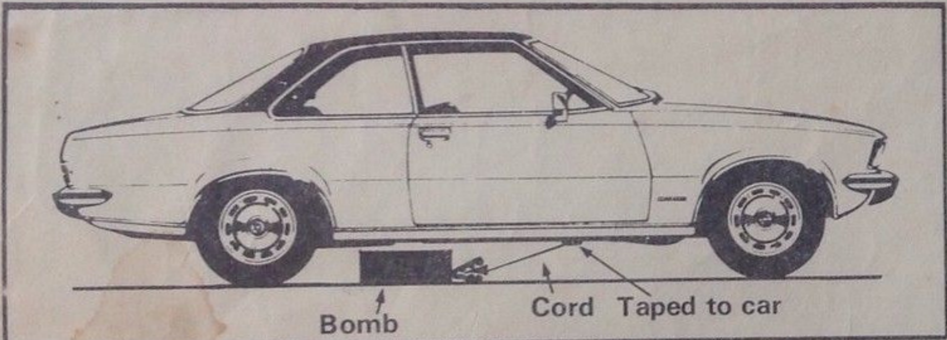
Occupation and waiting

362. An ambush should be occupied from the rear. All routes used must be carefully concealed.

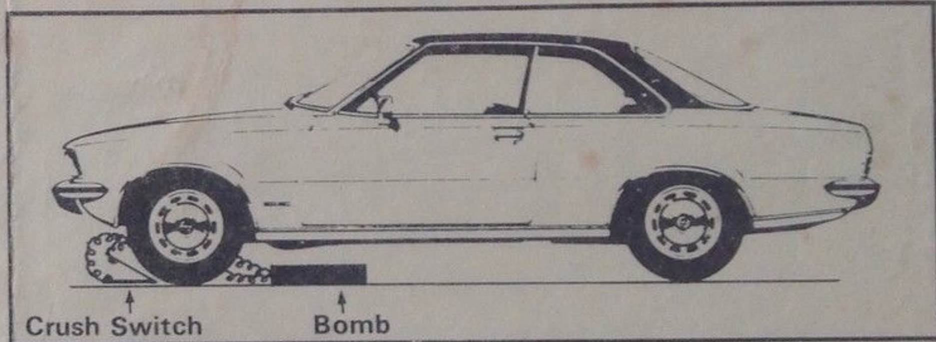
363. Weapons must be positioned so that they can bring point blank fire to bear. It may be possible to place some weapons in concealed positions in trees.

364. If an ambush is to be maintained for a long period, it may be possible for it to be manned initially only with look-outs, with the remaining men in an administrative rest area ready to come forward the moment anyone is seen or heard approaching. In these circumstances, concealed approach lanes connecting the administrative area with the ambush position will be required and a system of silent signals.

BEWARE OF BOOBY TRAPPED CARS



ON 17 MAY 1973 IN OMAGH A BOOBY TRAP OF THIS TYPE KILLED 5 SENIOR ARMY NCO'S



ON 12 DECEMBER 1973 IN NEWCASTLE A BOOBY TRAP OF THIS TYPE KILLED AN RUC CONSTABLE

IT COULD TAKE LESS THAN 5 MINUTES TO TURN A CAR INTO A BOMB - DON'T LET THE BOMBER GET AT YOURS.

ALWAYS PARK YOUR CAR IN A SECURE PLACE

IF THIS IS NOT POSSIBLE AND YOU MUST LEAVE IT UNATTENDED, THESE PRECAUTIONS MAY PREVENT

YOUR DEATH

INTO A BOMB - DON'T LET THE BOMBER GET AT YOURS.

ALWAYS PARK YOUR CAR IN A SECURE PLACE

IF THIS IS NOT POSSIBLE AND YOU MUST LEAVE IT UNATTENDED, THESE PRECAUTIONS MAY PREVENT YOUR DEATH

BEFORE LEAVING YOUR CAR

USE 'TELL TALES' TO INDICATE ANY INTERFERENCE—COTTON THREADS SECURED WITH SELLOTAPE ACROSS THE BONNET, DOORS AND BOOT WILL BE BROKEN IF ANYONE OPENS THE CAR.

'TELL TALE' OBJECTS SUCH AS MAGAZINES OR COATS PLACED ON THE SEATS MAY INDICATE IF THE INSIDE OF THE CAR HAS BEEN DISTURBED.

ON RETURNING TO YOUR CAR

BEFORE TOUCHING ANYTHING CHECK THE OUTSIDE OF THE CAR, PARTICULARLY YOUR 'TELL TALES', FOR SIGNS OF TAMPERING.

EXAMINE UNDERNEATH THE CAR FOR ANYTHING ON THE GROUND OR ATTACHED TO THE CHASSIS

IF YOU ARE IN ANY WAY SUSPICIOUS TELL THE NEAREST ARMY POST, POLICE STATION OR

DIAL 999

Issued by HQ Northern Ireland

Credit: Daily Express

Crimea, 3 March 2014

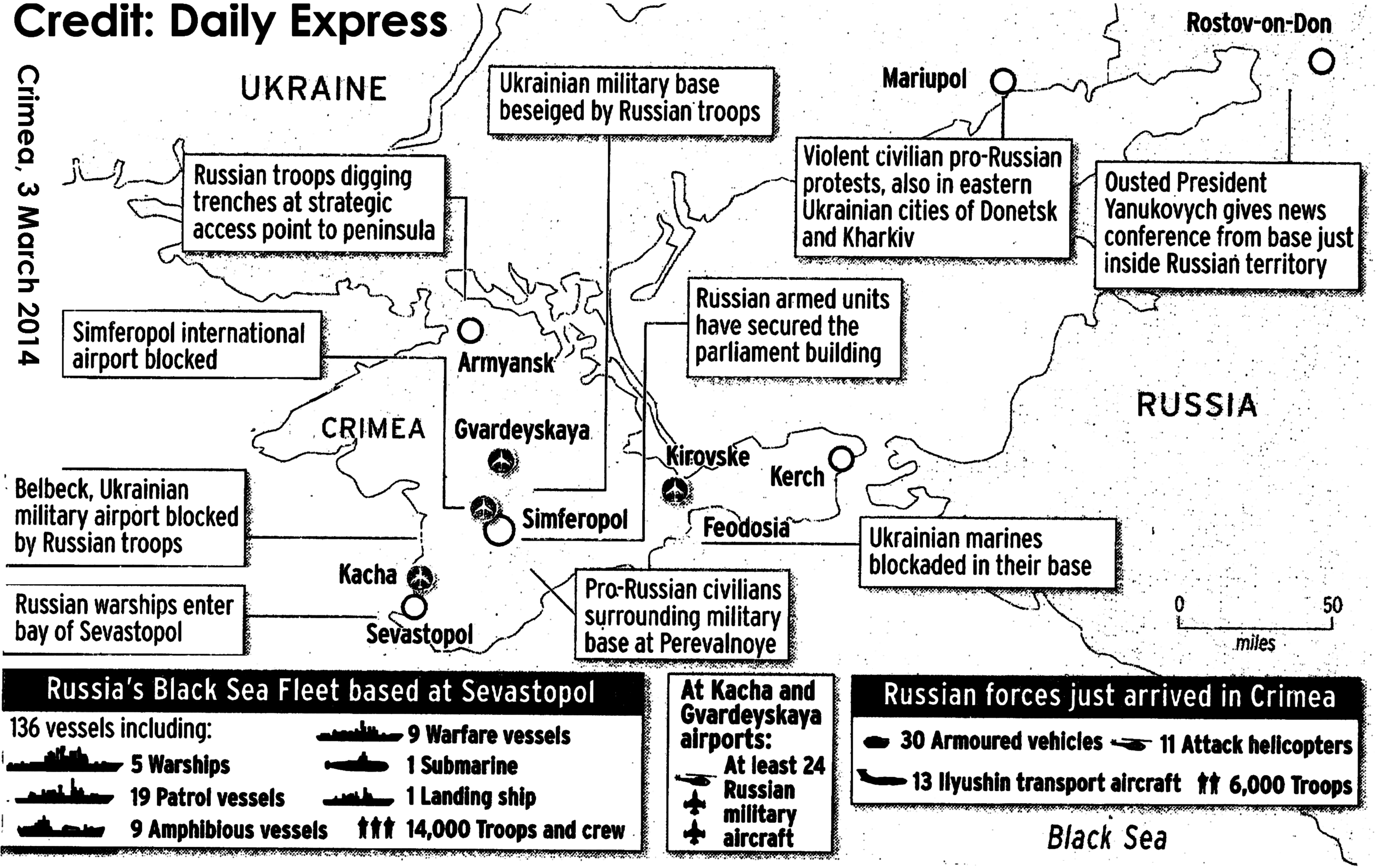


TABLE 14

The mechanics of intervention of the loyalist forces

Phase	*Effect of our general measures*
1. Police/security agency personnel raise initial alarm and seek to contact their HQ.	Telephone exchange has been seized, telex cable links have been sabotaged, radio relays are shut off. They must therefore send a verbal message.
2. Police/security agency HQ verify the reports and realize the seriousness of the threat. HQ tries to communicate with political leadership.	As above for communications. Some messengers fail to arrive as focal traffic points are gradually occupied.
3. Political leadership calls for army and police intervention.	As above for communications. Some units missing from their barracks; others refuse to move; others cannot move because of technical neutralization.
4. Political leaders begin to realize the extent of our infiltration of the armed forces and police. Loyalist troops respond.	As above for communications. Only military radio links can be used to communicate with loyalist forces.
5. Uninfiltrated forces assemble and prepare for intervention. They try to reach political leadership for a confirmation of their orders. Some defect to us, others choose neutrality, but some remain under the control of the government.	Many political leaders no longer available; some arrested and some in hiding.
6. Loyalist forces move on to capital city, or if already within its area move into the city center.	Airports closed and landing strips interdicted. Railways interrupted and trains stopped. City entry points controlled by our roadblocks.

Loyalist forces in capital city area are then isolated by direct means.

Fig. 6 OPERATIONAL SEQUENCE AND TIMING

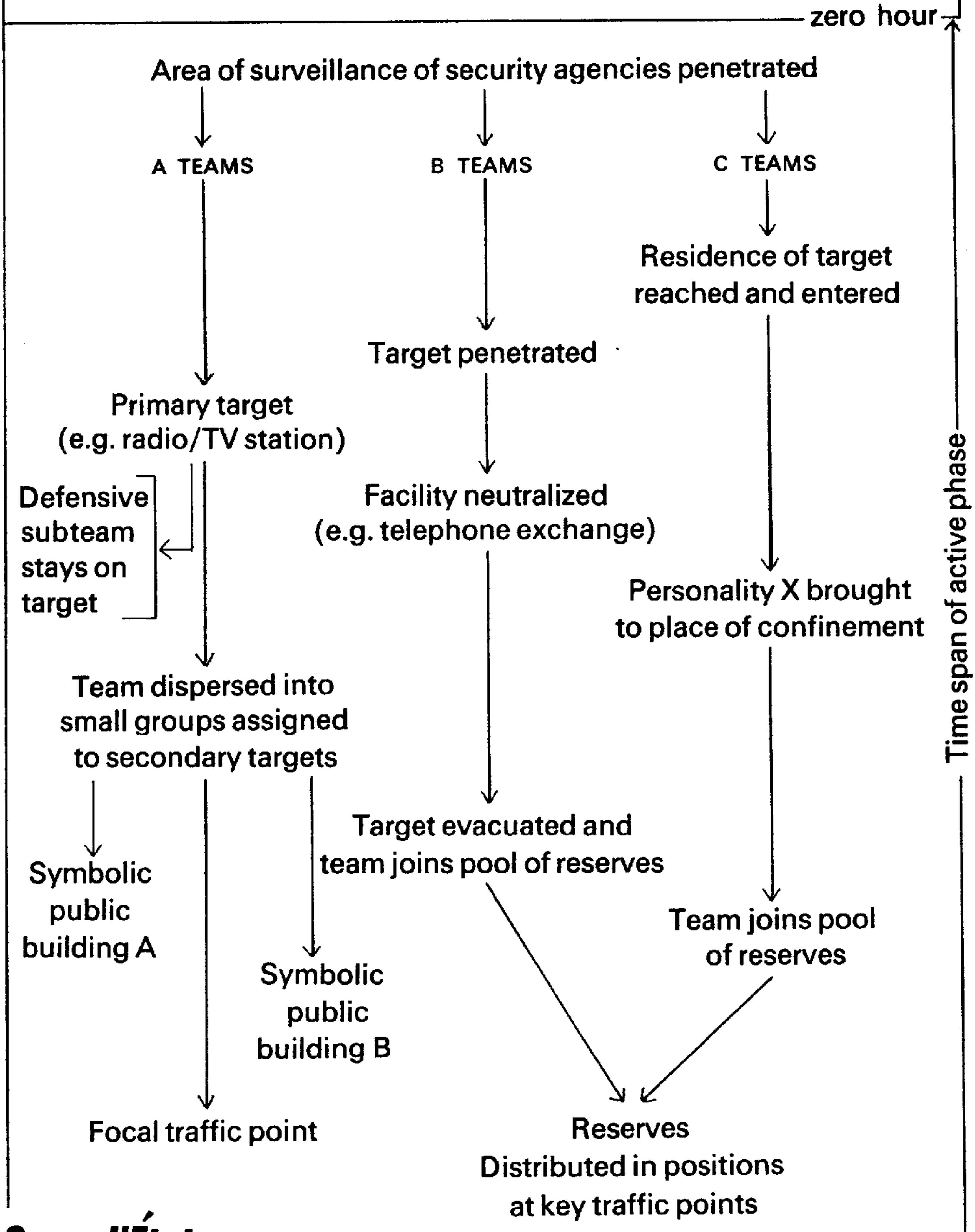
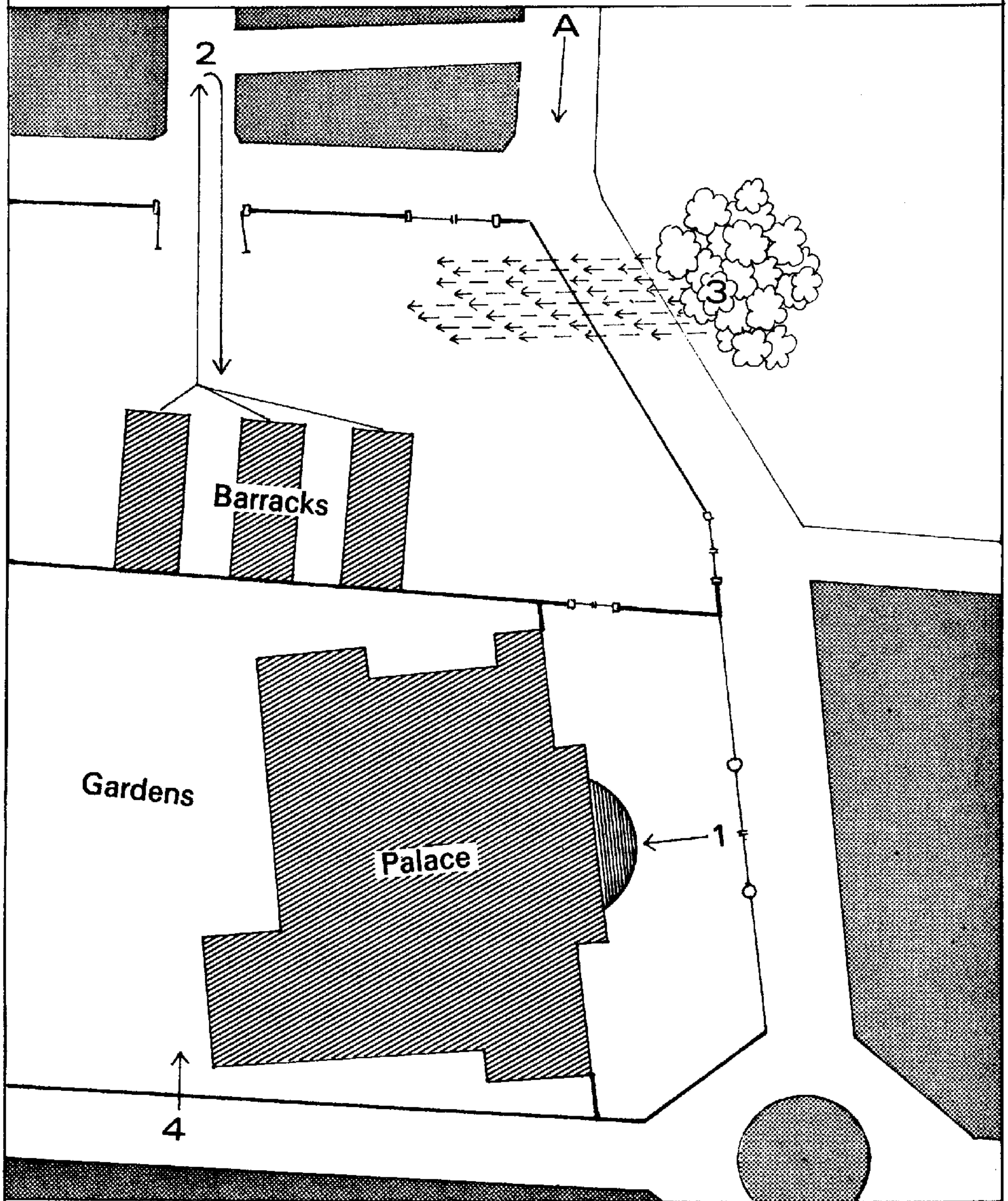


Fig. 12 "SOPHISTICATED" SEIZURE OF MAJOR DEFENDED TARGETS



SEQUENCE

1. Civilian penetration
2. Diversion designed to attract loyalist troops away from palace
3. Interdicting fire to prevent their return and the passage of the main loyalist forces
4. Assault group from street enters into action

A. Expected approach of main loyalist forces

~~Strictly Confidential~~

Memorandum on the properties of a radioactive "super-bomb".

The attached detailed report concerns the possibility of constructing a "super-bomb" which utilizes the energy stored in atomic nuclei as a source of energy. The energy liberated in the explosion of such a super-bomb is about the same as that produced by the explosion of 1000 tons of dynamite. This energy is liberated in a small volume, in which it will, for an instant, produce a temperature comparable to that in the interior of the sun. The blast from such an explosion would destroy life in a wide area. The size of this area is difficult to estimate, but it will probably cover the centre of a big city.

In addition, some part of the energy set free by the bomb goes to produce radioactive substances, and these will emit very powerful and dangerous radiations. The effect of these radiations is greatest immediately after the explosion, but it decays only gradually and even for days after the explosion any person entering the affected area will be killed.

Some of this radioactivity will be carried along with the wind and will spread the contamination; several miles downwind this may kill people.

The mechanism which brings the parts of the bomb together must be arranged to work fairly rapidly because of the possibility of the bomb exploding when the critical conditions have just only been reached. In this case the explosion will be far less powerful. It is never possible to exclude this altogether, but one can easily ensure that only, say, one bomb out of 100 will fail in this way, and since in any case the explosion is strong enough to destroy the bomb itself, this point is not serious.

As regards the reliability of the conclusions outlined above, it may be said that they are not based on direct experiments, since nobody has ever yet built a super-bomb, but they are mostly based on facts which, by recent research in nuclear physics, have been very safely established. The only uncertainty concerns the critical size for the bomb. We are fairly confident that the critical size is roughly a pound or so, but for this estimate we have to rely on certain theoretical ideas which have not been positively confirmed. If the critical size were appreciably larger than we believe it to be, the technical difficulties in the way of constructing the bomb would be enhanced. The point can be definitely settled as soon as a small amount of uranium has been separated, and we think that in view of the importance of the matter immediate steps should be taken to reach at least this stage; meanwhile it is also possible to carry out certain experiments which, while they cannot settle the question with absolute finality, could, if their result were positive, give strong support to our conclusions.

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